PROJECTS

PLANNING ANALYSIS SELECTION IMPLEMENTATION & REVIEW

FOURTH EDITION

PRASANNA CHANDRA

PROJECTS:
Planning, Analysis, Selection, Implementation, and Review

Fourth Edition

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Planning, Analysis, Selection, Implementation, and Review

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To

Prashant and Pranav

Preface

This book presents a framework for evaluating capital expenditure proposals that has been developed by financial economists. Often, the ad hoc procedures and rules of thumb employed by businessmen and practitioners are not compatible with the principles advocated by financial economists. This book explains the rationale behind these principles and suggests ways and means to improve project appraisal and capital budgeting in practice.

The book spans the gamut of capital budgeting, defined in its broadest sense. Beginning with project planning, it culminates in the review of projects undertaken. In this respect, it is wider in coverage than other books in this field. It analytically discusses various issues involved in project appraisal and capital budgeting. Both qualitative and quantitative methods are covered which improve quality of project analysis. Numerous illustrations and suitable examples to clarify various tools and techniques have been provided. Where necessary, two or three examples in ascending order of degree of complexity have also been included. Business practices have been described and evaluated in several important areas. Finally, the book carries a detailed discussion of the various aspects of the regulatory, tax, and financial arrangements prevailing in India.

The book is designed primarily for two categories of readers—students and practitioners. Students of professional programmes (like MBA, CFA, ACA, and AICWA) and post-graduate courses in Commerce, Finance, and Economics will benefit from this book. It should also be of value to corporate policy makers who formulate and shape the corporate investment strategies; to consultants and others who prepare project feasibility studies; to executives who have a say in the selection of projects and development of the firm's capital budget; to officials of banks and financial institutions who evaluate projects as lenders and investors; and to those who are concerned with implementing as well as reviewing projects.

The key guidelines relevant for project planning, analysis, and selection discussed in this book are:

- Develop a strategy that leads to a sustainable competitive advantage.
- Sharpen the ability of the firm to identify promising investment opportunities.
- Formulate the project, taking into account the interrelationships among various aspects.
- Forecast realistically the incremental cash flows attributable to the project.
- Establish a hurdle rate that is consistent with the risk exposure of the project.
- Calculate the net present value of the project.
- Value the options embedded in the project.
- Combine intuitive insights with analytical reasoning.

Changes in the Fourth Edition

This edition represents a substantial improvement over the third edition. The key enhancements are described below:

Addition of New Chapters Five new chapters have been added to broaden the coverage of the book—Resource Allocation Framework (Chapter 2), Special Decision Situations (Chapter 12), Options and Flexibility (Chapter 16), Qualitative Factors, Strategic Aspects, and Organisational Considerations (Chapter 17), and Project Review (Chapter 20).

Inclusion of Several Additional Appendices The following appendices have been added: Appendix 3A: Profit Potential of Industries: Porter Model; Appendix 4A: Methods of Demand Forecasting; Appendix 6A: Vegetron Limited: A Case Study on Financial Projections; Appendix 8C: Formulae for Growing or Declining Streams; Appendix 9B: Cost of Depreciation: Generated Funds; Appendix 9C: Systems of Weighting for Determining the Cost of Capital; Appendix 11E: Certainty Equivalent Method vs Risk Adjusted Discount Rate Method.

Strengthening of Various Chapters While every chapter of the previous edition has been strengthened, the following chapters have been improved substantially: Chapter 1: Overview; Chapter 3: Generation and Screening of Project Ideas; Chapter 4: Market and Demand Analysis; Chapter 6: Financial Analysis; Chapter 7: Project Cash Flows; Chapter 9: Cost of Capital; Chapter 10: Appraisal Criteria; Chapter 11: Analysis of Risk; Chapter 13: Risk Analysis: Firm Risk and Market Risk; Chapter 15: Multiple Projects and Constraints; and Chapter 18: Project Management.

Restructuring of the Material on Financial Analysis The material on financial analysis, which was covered in three separate chapters earlier, has now been covered more systematically, cohesively, and comprehensively in one chapter. Further, the discussion on 'Project Financing in India' and 'Tax Aspects of Projects' have been pushed to the appendices at the end of the book so that they can be updated periodically.

Organisation of the Book

Organised in terms of the broad phases of capital budgeting, the book is divided into six sections.

Part 1 *Planning* Consisting of Chapters 1 through 3, Part 1 is concerned with the planning phase of capital budgeting. Chapter 1 provides an overview of capital budgeting. Chapter 2 discusses key criteria, models, and considerations that are helpful in articulating the resource allocation strategy of a firm. Chapter 3 looks at the ways and means of generating project ideas and screening them at a preliminary level.

Part 2 *Analysis* Chapters 4 through 6 focus on gathering and analysing basic information about the project. Chapter 4 discusses the key steps involved in market and demand analysis. Chapter 5 dwells on various facets of technical analysis. Chapter 6 explains how financial estimates and projections relating to a project are developed.

Part 3 *Selection-I* The material relating to the selection phase is very extensive. So it has been divided into two parts, Selection-I, and Selection-II. Selection-I, consisting of Chapters 7-11, focuses on the basic concepts, principles, and techniques of selection. Chapter 7 shows how project cash flows are defined. Chapter 8 discusses the principles of compounding and discounting. Chapter 9 explains the concept and measurement of cost of capital. Chapter 10 extensively covers various appraisal criteria. Finally, Chapter 11 expounds the techniques for measuring and evaluating the stand-alone risks of projects.

Part 4 *Selection-II* Concerned with more advanced techniques of selection or broader methodologies of evaluation, Part 4 consists of Chapters 12-17. Chapter 12 looks at how investment decisions may be made in certain special situations. Chapter 13 discusses the risk of a project in terms of firm risk and market risk. Chapter 14 presents the methodology of social cost benefit analysis. Chapter 15 explains how the capital budget of the firm may be drawn up in face of constraints, using the technique of mathematical programming. Chapter 16 looks at the key insights provided by the option pricing theory and how the same may be employed for valuing the options embedded in capital projects. Chapter 17 explores the qualitative, strategic, and organisational issues relating to capital budgeting.

Part 5 *Implementation* Consisting of Chapters 18 and 19, Part 5 focuses on the implementation of selected projects. Chapter 18 discusses various aspects of project management. Chapter 19 explains how network techniques (Programme Evaluation Review Technique, Critical Path Method, and Network Cost System) may be employed for project planning, scheduling, and control.

Part 6 *Review* Chapter 20 discusses various issues involved in project review. It also covers the administrative aspects of capital budgeting.

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Acknowledgements

I am indebted to my students and the participants of executive development programmes conducted by me for providing the stimulus for writing this book. They pointed to the need for a comprehensive book, akin to a manual, on managing capital expenditures.

In writing this book I have drawn on materials from a variety of disciplines that have a bearing on different facets of project appraisal and capital budgeting. I owe a profound intellectual debt to numerous authors whose ideas and contributions have shaped my thinking on this subject.

I am grateful to Profs. Sundararajan and Naganna for their valuable contributions and to a number of practitioners who have generously shared their views with me. I am thankful to Venkata Rao, Simon, and Krishnamurthy for their help in typing the manuscript. My deepest gratitude is to my wife, Padma, for her support and encouragement.

At places I have drawn on my articles published in *Indian Management*, *Chartered Accountant*, *Management Accountant*, *Chartered Financial Analyst*, *Decision* and *Lok Udyog*. I am grateful to the editors of these journals.

May I request the readers to send their suggestions for improving this book.

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PART 1

PLANNING

Overview

Resource Allocation Framework

Generation and Screening of Project Ideas

1

Overview

A mini-steel plant is considering building a new arc furnace; an insurance company is planning to install a computer system for information processing; the Government of India is thinking of an ambitious plan to link Ganges and Cauvery rivers; Gautam, a graduate student, is planning to buy a moped. All these situations involve a capital expenditure decision. Essentially, each of them represents a scheme for investing resources which can be analysed and appraised reasonably independently. The basic characteristic of a capital expenditure[1] (also referred to as a capital investment or capital project or just project) is that it typically involves a current outlay (or current and future outlays) of funds in the expectation of a stream of benefits extending far into future.

This chapter provides a broad overview of the field of project appraisal and capital budgeting. It is divided into five sections as follows:

- Capital expenditures: importance and difficulties
- Phases of capital budgeting
- Levels of decision making
- Facets of project analysis
- Feasibility study: a schematic diagram
- Objectives of capital budgeting

CAPITAL EXPENDITURES: IMPORTANCE AND DIFFICULTIES

Importance

Capital expenditure decisions often represent the most important decisions taken by a firm. Their importance stems from three inter-related reasons:

---

[1] This definition of a capital expenditure is not necessarily synonymous with how a capital expenditure is defined in accounting. A capital expenditure, from the accounting point of view, is an expenditure which is shown as an asset in the balance sheet. This asset, except in the case of a non-depreciable asset like land, is depreciated over its life. In accounting, the classification of an expenditure as a capital expenditure or a revenue expenditure is governed by certain conventions, by some provisions of law, and by the management's desire to enhance or depress reported profits. Often, outlays on research and development, major advertising campaigns, and reconditioning of plant and machinery may be treated as revenue expenditures for accounting purposes, even though they are expected to generate a stream of benefits in future and, therefore, qualify for being capital expenditures as per our definition

- *Long-Term Effects* The consequences of capital expenditure decisions extend far into the future. The scope of current manufacturing activities of a firm is governed largely by capital expenditures in the past. Likewise, current capital expenditure decisions provide the framework for future activities. Capital investment decisions have an enormous bearing on the basic character of a firm.
- *Irreversibility* The market for used capital equipment in general is ill-organised. Further, for some types of capital equipments, custom-made to meet specific requirement, the market may virtually be non-existent. Once such an equipment is acquired, reversal of decision may mean scrapping the capital equipment. Thus, a wrong capital investment decision, often cannot be reversed without incurring a substantial loss.
- *Substantial Outlays* Capital expenditures usually involve substantial outlays. An integrated steel plant, for example, involves an outlay of several thousand millions. Capital costs tend to increase with advanced technology.

Difficulties

While capital expenditure decisions are extremely important, they also pose difficulties which stem from three principal sources:

- *Measurement Problems* Identifying and measuring the costs and benefits of a capital expenditure proposal tends to be difficult. This is more so when a capital expenditure has a bearing on some other activities of the firm (like cutting into the sales of some existing product) or has some intangible consequences (like improving the morale of workers).
- *Uncertainty* A capital expenditure decision involves costs and benefits that extend far into future. It is impossible to predict exactly what will happen in future. Hence, there is usually a great deal of uncertainty characterising the costs and benefits of a capital expenditure decision.
- *Temporal Spread* The costs and benefits associated with a capital expenditure decision are spread out over a long period of time, usually 10–20 years for industrial projects and 20–50 years for infrastructural projects. Such a temporal spread creates some problems in estimating discount rates and establishing equivalences.

PHASES OF CAPITAL BUDGETING

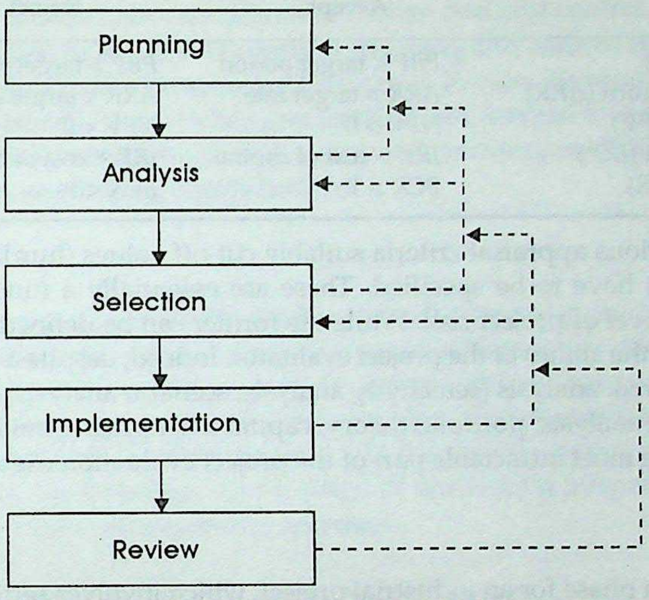
Capital budgeting is a complex process which may be divided into five broad phases: planning, analysis, selection, implementation, and review. Exhibit 1.1 portrays the relationship among these phases. The solid arrows reflect the main sequence: planning precedes analysis; analysis precedes selection; and so on. The dashed arrows indicate that the phases of capital budgeting are not related in a simple, sequential manner. Instead, there are several feedback loops reflecting the iterative nature of the process.

Planning

The planning phase of a firm's capital budgeting process is concerned with the articulation of its broad investment strategy and the generation and preliminary screening of project proposals. The investment strategy of the firm delineates the broad areas or types of

EXHIBIT 1.1

Capital Budgeting Process



investments the firm plans to undertake. This provides the framework which shapes, guides, and circumscribes the identification of individual project opportunities.

Once a project proposal is identified, it needs to be examined. To begin with, a preliminary project analysis is done. A prelude to the full blown feasibility study, this exercise is meant to assess (i) whether the project is prima facie worthwhile to justify a feasibility study and (ii) what aspects of the project are critical to its viability and hence warrant an in-depth investigation.

Analysis

If the preliminary screening suggests that the project is prima facie worthwhile, a detailed analysis of the marketing, technical, financial, economic, and ecological aspects is undertaken. The questions and issues raised in such a detailed analysis are described in the following section. The focus of this phase of capital budgeting is on gathering, preparing, and summarising relevant information about various project proposals which are being considered for inclusion in the capital budget. Based on the information developed in this analysis, the stream of costs and benefits associated with the project can be defined.

Selection

Selection follows, and often overlaps, analysis. It addresses the question—Is the project worthwhile? A wide range of appraisal criteria have been suggested to judge the worthwhileness of a project. They are divided into two broad categories, viz., non-discounting criteria and discounting criteria. The principal non-discounting criteria are the payback period and the accounting rate of return. The key discounting criteria are the net present value, the internal rate of return, and the benefit cost ratio. The selection rules associated with these criteria are as follows:

Criterion	Accept	Reject
Payback period (*PBP*)	*PBP* < target period	*PBP* > target period
Accounting rate of return (*ARR*)	*ARR* > target rate	*ARR* < target rate
Net present value (*NPV*)	*NPV* > 0	*NPV* < 0
Internal rate of return (*IRR*)	*IRR* > cost of capital	*IRR* < cost of capital
Benefit cost ratio (*BCR*)	*BCR* > 1	*BCR* < 1

To apply the various appraisal criteria suitable cut-off values (hurdle rate, target rate, and cost of capital) have to be specified. These are essentially a function of the mix of financing and the level of project risk. While the former can be defined with relative ease, the latter truly tests the ability of the project evaluator. Indeed, despite a wide range of tools and techniques for risk analysis (sensitivity analysis, scenario analysis, Monte Carlo simulation, decision tree analysis, portfolio theory, capital asset pricing model, and so on), risk analysis remains the most intractable part of the project evaluation exercise.

Implementation

The implementation phase for an industrial project, which involves setting up of manufacturing facilities, consists of several stages: (i) project and engineering designs, (ii) negotiations and contracting, (iii) construction, (iv) training, and (v) plant commissioning. What is done in these stages is briefly described below:

Stage	Concerned with
Project and engineering designs	Site probing and prospecting, preparation of blueprints, and plant designs, plant engineering, selection of specific machineries and equipment.
Negotiations and contracting	Negotiating and drawing up of legal contracts with respect to project financing, acquisition of technology, construction of building and civil works, provision of utilities, supply of machinery and equipment, marketing arrangements, etc.
Construction	Site preparation, construction of buildings and civil works, erection and installation of machinery and equipment.
Training	Training of engineers, technicians, and workers. (This can proceed simultaneously along with the construction work.)
Plant commissioning	Start up of the plant. (This is a brief but commissioning technically crucial stage in the project development cycle.)

Translating an investment proposal into a concrete project is a complex, time-consuming, and risk-fraught task. Delays in implementation, which are common, can lead to substantial cost overruns. For expeditious implementation at a reasonable cost, the following are helpful.

1. *Adequate Formulation of Projects* A major reason for the delay is inadequate formulation of projects. Put differently, if necessary homework in terms of preliminary studies and comprehensive and detailed formulation of the project is not done,

many surprises and shocks are likely to spring on the way. Hence, the need for adequate formulation of the project cannot be over-emphasised.

2. *Use of the Principle of Responsibility Accounting* Assigning specific responsibilities to project managers for completing the project within the defined time-frame and cost limits is helpful in expeditious execution and cost control.
3. *Use of Network Techniques* For project planning and control two basic techniques are available—PERT (Programme Evaluation Review Technique) and CPM (Critical Path Method). These techniques have, of late, merged and are being referred to by a common terminology, that is network techniques. With the help of these techniques, monitoring becomes easier.

Review

Once the project is commissioned the review phase has to be set in motion. Performance review should be done periodically to compare actual performance with projected performance. A feedback device, it is useful in several ways: (i) It throws light on how realistic were the assumptions underlying the project; (ii) It provides a documented log of experience that is highly valuable in future decision making; (iii) It suggests corrective action to be taken in the light of actual performance; (iv) It helps in uncovering judgemental biases; (v) It induces a desired caution among project sponsors.

LEVELS OF DECISION MAKING

In addition to looking at the various phases of capital budgeting, researchers have also examined different levels of decision making. Gordon, Miller, and Mintzberg[2], for example, defined three levels of decision making: operating, administrative, and strategic. The key characteristics of decisions at these levels are described below:

	Operating decisions	Administrative decisions	Strategic decisions
Where is the decision taken	Lower level management	Middle level management	Top level management
How structured is the decision	Routine	Semi-structured	Unstructured
What is the level of resource commitment	Minor resource commitment	Moderate resource commitment	Major resource commitment
What is the time horizon	Short-term	Medium-term	Long-term

The three levels (operating, administrative, and strategic) of decision making can be readily applied to capital budgeting decisions. Examples are given below:

Operating capital budgeting decision	:	Minor office equipment
Administrative capital budgeting decision	:	Balancing equipment
Strategic capital budgeting decision	:	Diversification project

---

[2] Gordon, L.A., Miller, D. and Mintzberg, H. *Normative Models of Managerial Decision-Making*, New York: National Association of Accountants, 1975.

While the methods and techniques covered in this book are applicable to all levels of capital budgeting decisions, our discussion will mainly be oriented towards administrative and strategic capital budgeting decisions.

FACETS OF PROJECT ANALYSIS

The important facets of project analysis are:
- Market analysis
- Technical analysis
- Financial analysis
- Economic analysis
- Ecological analysis

Market Analysis

Market analysis is concerned primarily with two questions:
- What would be the aggregate demand of the proposed product/service in future?
- What would be the market share of the project under appraisal?

To answer the above questions, the market analyst requires a wide variety of information and appropriate forecasting methods. The kinds of information required are:

- Consumption trends in the past and the present consumption level
- Past and present supply position
- Production possibilities and constraints
- Imports and exports
- Structure of competition
- Cost structure
- Elasticity of demand
- Consumer behaviour, intentions, motivations, attitudes, preferences, and requirements
- Distribution channels and marketing policies in use
- Administrative, technical, and legal constraints

Technical Analysis

Analysis of the technical and engineering aspects of a project needs to be done continually when a project is formulated. Technical analysis seeks to determine whether the prerequisites for the successful commissioning of the project have been considered and reasonably good choices have been made with respect to location, size, process, etc. The important questions raised in technical analysis are:
- Whether the preliminary tests and studies have been done or provided for?
- Whether the availability of raw materials, power, and other inputs has been established?
- Whether the selected scale of operation is optimal?
- Whether the production process chosen is suitable?
- Whether the equipment and machines chosen are appropriate?

- Whether the auxiliary equipments and supplementary engineering works have been provided for?
- Whether provision has been made for the treatment of effluents?
- Whether the proposed layout of the site, buildings, and plant is sound?
- Whether work schedules have been realistically drawn up?
- Whether the technology proposed to be employed is appropriate from the social point of view?

Financial Analysis

Financial analysis seeks to ascertain whether the proposed project will be financially viable in the sense of being able to meet the burden of servicing debt and whether the proposed project will satisfy the return expectations of those who provide the capital. The aspects which have to be looked into while conducting financial appraisal are:

- Investment outlay and cost of project
- Means of financing
- Cost of capital
- Projected profitability
- Break-even point
- Cash flows of the project
- Investment worthwhileness judged in terms of various criteria of merit
- Projected financial position
- Level of risk

Economic Analysis

Economic analysis, also referred to as social cost benefit analysis, is concerned with judging a project from the larger social point of view. In such an evaluation the focus is on the social costs and benefits of a project which may often be different from its monetary costs and benefits. The questions sought to be answered in social cost benefit analysis are:

- What are the direct economic benefits and costs of the project measured in terms of shadow (efficiency) prices and not in terms of market prices?
- What would be the impact of the project on the distribution of income in the society?
- What would be the impact of the project on the level of savings and investment in the society?
- What would be the contribution of the project towards the fulfillment of certain merit wants like self-sufficiency, employment, and social order?

Ecological Analysis

In recent years, environmental concerns have assumed a great deal of significance—and rightly so. Ecological analysis should be done particularly for major projects which have significant ecological implications like power plants and irrigation schemes, and environmental—polluting industries (like bulk drugs, chemicals, and leather processing). The key questions raised in ecological analysis are:

- What is the likely damage caused by the project to the environment?

- What is the cost of restoration measures required to ensure that the damage to the environment is contained within acceptable limits?

Exhibit 1.2 summarises the key issues considered in different types of analysis:

EXHIBIT 1.2

Key Issues in Project Analysis

Market Analysis	Potential Market Market Share
Technical Analysis	Technical Viability Sensible Choices
Financial Analysis	Risk Return
Economic Analysis	Benefits and Costs in Shadow Prices Other Impacts
Ecological Analysis	Environmental Damage Restoration Measures

FEASIBILITY STUDY: A SCHEMATIC DIAGRAM

We have looked at the five broad phases of capital budgeting and examined the key facets of project analysis. The feasibility study is concerned with the first three phases of capital budgeting, viz., planning, analysis, and selection (evaluation) and involves market, technical, financial, economic, and ecological analysis. The schematic diagram of the feasibility study is shown in Exhibit 1.3.

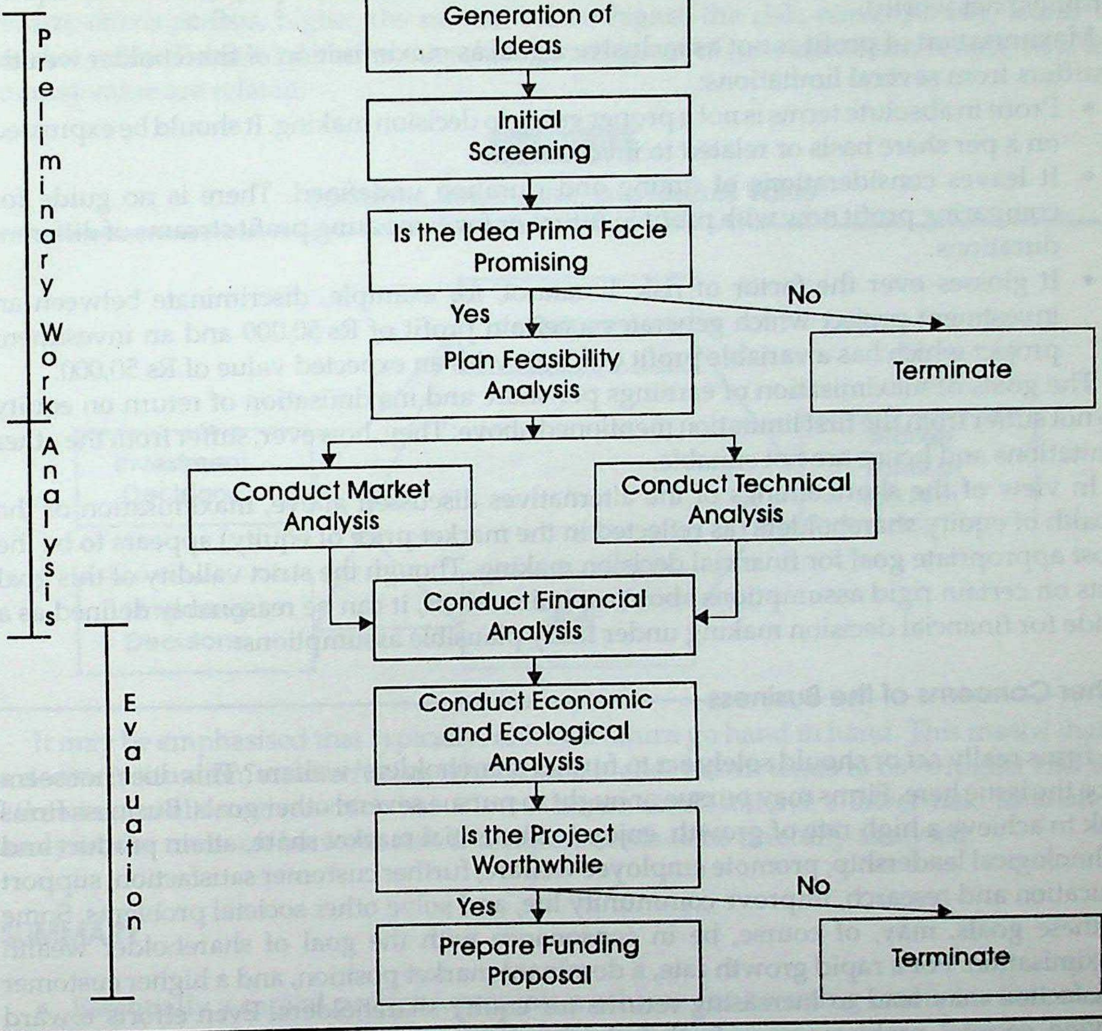
OBJECTIVES OF CAPITAL BUDGETING

Financial theory, in general, rests on the premise that the goal of financial management (which subsumes investment decision making) should be to maximise the present wealth of the firm's equity shareholders. For a firm whose equity shares are actively traded on the stock market, the wealth of the equity shareholders is reflected in the market value of the equity shares. Hence, the goal of financial management for such firms should be to maximise the market value of equity shares.

The pursuit of the welfare of equity shareholders is justified on the grounds that it contributes to an efficient allocation of capital in the economy. The bases for allocation of savings in the economy are expected return and risk. Since equity share prices are based on expected return and risk, efforts to maximise equity share prices would result in an efficient allocation of resources. Another justification may be provided for the goal of shareholder

EXHIBIT 1.3

Feasibility Study: A Schematic Diagram


Preliminary Work Analysis
Generation of Ideas
Initial Screening
Is the Idea Prima Facie Promising
No
Yes
Terminate
Plan Feasibility Analysis
Conduct Market Analysis
Conduct Technical Analysis
Conduct Financial Analysis
Evaluation
Conduct Economic and Ecological Analysis
Is the Project Worthwhile
No
Yes
Prepare Funding Proposal
Terminate

wealth maximisation. Equity shareholders provide the venture (risk) capital required to start a business firm and appoint the management of the firm indirectly through the board of directors. Hence, it behooves on corporate managements to promote the welfare of equity shareholders.

What about a public sector firm the equity stock of which, being fully owned by the government, is not traded on the stock market? In such a case, the goal of financial management should be to maximise the present value of the stream of equity returns. Of course, in determining the present value of the stream of equity returns, an appropriate discount rate has to be applied. A similar observation may be made with respect to other companies whose equity shares are either not traded or very poorly traded.

Alternatives

Are there other goals, besides the goal of maximum shareholder wealth, expressing the shareholders' viewpoint? Several alternatives have been suggested: maximisation of profit, maximisation of earnings per share, maximisation of return on equity (defined as equity earnings/net worth).

Maximisation of profit is not as inclusive a goal as maximisation of shareholder wealth. It suffers from several limitations:

- Profit in absolute terms is not a proper guide to decision making. It should be expressed on a per share basis or related to investment.
- It leaves considerations of timing and duration undefined. There is no guide for comparing profit now with profit in future or for comparing profit streams of different durations.
- It glosses over the factor of risk. It cannot, for example, discriminate between an investment project which generates a certain profit of Rs 50,000 and an investment project which has a variable profit outcome with an expected value of Rs 50,000.

The goals of maximisation of earnings per share and maximisation of return on equity do not suffer from the first limitation mentioned above. They, however, suffer from the other limitations and hence are not suitable.

In view of the shortcomings of the alternatives discussed above, maximisation of the wealth of equity shareholders (as reflected in the market price of equity) appears to be the most appropriate goal for financial decision making. Though the strict validity of this goal rests on certain rigid assumptions about capital markets, it can be reasonably defined as a guide for financial decision making under fairly plausible assumptions.

Other Concerns of the Business

Do firms really act or should solely act to further shareholders' welfare? This does not seem to be the issue here. Firms may pursue or ought to pursue several other goals. Business firms seek to achieve a high rate of growth, enjoy a substantial market share, attain product and technological leadership, promote employee welfare, further customer satisfaction, support education and research, improve community life, and solve other societal problems. Some of these goals, may, of course, be in consonance with the goal of shareholder wealth maximisation. For a rapid growth rate, a dominant market position, and a higher customer satisfaction may lead to increasing returns for equity shareholders. Even efforts toward solving societal problems may further the interest of shareholders in the long run by improving the image of the firm and strengthening its relationship with the environment. When these other goals seem to conflict with the goal of maximising the wealth of equity shareholders, it is helpful to know the cost of pursuing these goals. The trade-off has to be understood. It should be appreciated that the maximisation of the wealth of equity shareholders constitutes the principal guarantee for efficient allocation of resources in the economy and hence is to be regarded as the normative goal from the financial point of view.

Basic Considerations: Risk and Return

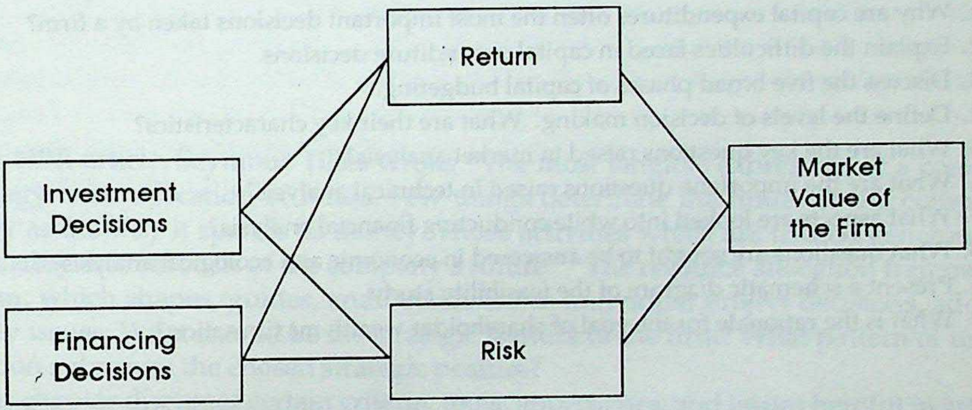
Suppose a firm is evaluating an investment proposal. What aspects are relevant from the financial angle? From the financial point of view the relevant dimensions are return and risk.

Take another decision situation in which the firm is considering a financing proposal. The aspects along which such a proposal is examined are cost and risk. Since cost is the inverse of return, here too the basic dimensions are return and risk. In general, we find that these are the two basic dimensions of financial analysis.

What is the relationship between return, risk, and market value of equity? Higher the return, *ceteris paribus*, higher the market value; higher the risk, *ceteris paribus*, lower the market value. Exhibit 1.4 shows the schematic diagram of how decisions, return, risk, and market value are related.

EXHIBIT 1.4

Decisions, Return, Risk, and Market Value



It may be emphasised that typically, risk and return go hand in hand. This means that in a decision situation, an alternative which has a higher return tends to have higher risk too. Likewise, an alternative which has a lower return tends to have a lower risk. In financial analysis, the trade-off between risk and return needs to be carefully analysed.

SUMMARY

- Essentially a capital project represents a scheme for investing resources that can be analysed and appraised reasonably independently.
- The basic characteristic of a capital project is that it typically involves a current outlay (or current and future outlays) of funds in the expectation of a stream of benefits extending far into future.
- Capital expenditure decisions often represent the most important decisions taken by a firm. Their importance stems from three inter-related reasons: long-term effects, irreversibility, and substantial outlays.
- While capital expenditure decisions are extremely important, they pose difficulties which stem from three principal sources: measurement problems, uncertainty, and temporal spread.
- Capital budgeting is a complex process which may be divided into five broad phases: planning, analysis, selection, implementation, and review.

- One can look at capital budgeting decisions at three levels: operating, administrative, and strategic.
- The important facets of project analysis are: market analysis, technical analysis, financial analysis, economic analysis, and ecological analysis.
- Financial theory, in general, rests on the premise that the goal of financial management should be to maximise the present wealth of the firm's equity shareholders. Business firms may pursue other goals. When these other goals conflict with the goal of maximising the wealth of equity shareholders, the trade-off has to be understood.

QUESTIONS

1. Why are capital expenditures often the most important decisions taken by a firm?
2. Explain the difficulties faced in capital expenditure decisions.
3. Discuss the five broad phases of capital budgeting.
4. Define the levels of decision making. What are their key characteristics?
5. What are the key questions raised in market analysis?
6. What are the important questions raised in technical analysis?
7. What aspects are looked into while conducting financial analysis?
8. What questions are sought to be answered in economic and ecological analysis?
9. Present a schematic diagram of the feasibility study.
10. What is the rationale for the goal of shareholder wealth maximisation?

2

Resource Allocation Framework

In an HBR article, Seymour Tilles wrote: "The most tangible expression of a company's strategy is its allocation of funds. Few things determine the future of the company as directly as the way it spends its money. Those activities which are treated generously are presumably the real basis of the company's future."[1] The resource allocation framework of the firm, which shapes, guides, and circumscribes individual project decisions, addresses two key issues: What should be the strategic posture of the firm? What pattern of resource allocation subserves the chosen strategic posture?

This chapter discusses certain criteria, tools, approaches, and issues helpful in articulating the resource allocation framework of the firm. It is divided into six sections as follows:

- Key criteria
- Elementary investment strategies
- Portfolio planning tools
- Strategic position and action evaluation
- Diversification debate
- Interface between strategic planning and capital budgeting

KEY CRITERIA

The objective of maximising the wealth of shareholders is reflected, at the operational level, in three key criteria: profitability, risk, and growth.

Profitability The principal driving force for business activity, profitability reflects the relationship between profit and investment. While there are numerous ways of measuring profitability, return on equity is one of the most widely used. It is defined as:

$$\frac{\text{Profit after tax}}{\text{Networth}}$$

In our present discussion, we will employ this measure.

Risk The search for profitable activities almost invariably entails risk. It reflects variability: How much do individual outcomes deviate from the expected value? A simple measure of variability is the *range* of possible outcomes, which is simply the difference between the highest and lowest outcomes. For our present purposes, we will define risk in terms of the range of return on equity, our chosen measure of profitability.

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[1] Tilles, Seymour, "Strategies for Allocating Funds", *Harvard Business Review*, January-February 1966.

Growth Business firms actively pursue and achieve growth over a period of time. This is manifested in the increase of revenues, assets, net worth, profits, dividends, and so on. To reflect the growth of a variable, the measure commonly employed is the compound rate of growth. We will look at the compound rate of growth of profit after tax.

It must be emphasised that the three criteria described above, viz., profitability, risk, and growth capture all facets of business performance. In addition, conceptually they are independent of each other. This point may be illustrated with the help of Exhibit 2.1 which provides information on equity (net worth), profit after tax, dividends and return on equity for three different pairs of firms over a period of few years.

Panel 1 of Exhibit 2.1 shows the comparative picture for two firms, A and B. Looking at this panel, we find that A and B are identical with respect to average profitability (return on equity) and growth (compound rate of growth of profit after tax) but dissimilar in terms of risk (range of return on equity). Panel 2 depicts the comparative picture for two firms, C and D. Looking at this panel, we find that C and D are identical with respect to growth and risk but dissimilar in terms of profitability. Panel 3 displays the comparative picture for two firms, E and F. Looking at this panel we find that E and F are identical with respect to average profitability and risk, but different in terms of growth.

ELEMENTARY INVESTMENT STRATEGIES

The building blocks of the corporate resource allocation strategy are the following elementary investment strategies:

- Replacement and modernisation
- Capacity expansion
- Vertical integration
- Concentric diversification
- Conglomerate diversification
- Divestment

Replacement and Modernisation

Often regarded as an integral part of the 'base level' capital expenditure programme, replacement and modernisation investments are meant to maintain (as well as augment) the production capacity of the firm, improve quality, and reduce costs. Without such investments, which are undertaken more or less routinely by well-managed firms, the competitive strength of the firm in its existing line of business can be significantly impaired. Indeed, if such investments are neglected, the very existence of the firm can be jeopardised. This has happened in the case of a large number of textile and other units in India.

Capacity Expansion

When a company anticipates growth in the market size of its product range or increase in the market share enjoyed by it in its product range, expansion of the capacity of the existing product range would have great appeal. Such an expansion offers several advantages:

familiarity with technology, production methods, and market conditions; lower capital costs due to the existence of surplus capacity in certain sections of the factory; reduction in unit overhead costs because of larger volume of production. These advantages, however, should

EXHIBIT 2.1

Profitability, Growth, and Risk

Panel 1

	A				B			
	Yr 1	Yr 2	Yr 3	Yr 4	Yr 1	Yr 2	Yr 3	Yr 4
Equity	100	100	100	100	100	100	100	100
Profit after tax	20	20	20	20	20	30	10	20
Dividends	20	20	20	20	20	30	10	20
Return on equity	20%	20%	20%	20%	20%	30%	10%	20%

Average profitability	:	20%	Average profitability	:	20%
Growth	:	0%	Growth	:	0%
Risk	:	0%	Risk	:	20%

Panel 2

	C				D			
	Yr 1	Yr 2	Yr 3	Yr 4	Yr 1	Yr 2	Yr 3	Yr 4
Equity	100	100	100	100	100	100	100	100
Profit after tax	30	30	30	30	20	20	20	20
Dividends	30	30	30	30	20	20	20	20
Return on equity	30%	30%	30%	30%	20%	20%	20%	20%

Average profitability	:	30%	Average profitability	:	20%
Growth	:	0%	Growth	:	0%
Risk	:	0%	Risk	:	0%

Panel 3

	E				F			
	Yr 1	Yr 2	Yr 3	Yr 4	Yr 1	Yr 2	Yr 3	Yr 4
Equity	100	120	144	172.8	100	100	100	100
Profit after tax	40	48	57.6	69.12	40	40	40	40
Dividends	20	24	28.8	34.56	40	40	40	40
Return on equity	40%	40%	40%	40%	40%	40%	40%	40%

Average profitability	:	40%	Average profitability	:	20%
Growth	:	20%	Growth	:	0%
Risk	:	0%	Risk	:	20%

be weighed against the possibility of market saturation and risk of excessive dependence on the existing product range.

Vertical Integration

Vertical integration may be of two types: backward integration and forward integration. Backward integration involves manufacture of raw materials and components required for the existing operations of the company. For example, Reliance Industries Limited set up a unit for the manufacture of polyester filament yarn required for its textile units. Forward integration involves the manufacture of products which use the existing products of the company as input. For example, Bharat Forge Company set up an automotive axles unit which uses its forgings as input. Vertical integration, backward or forward, provides greater stability to the existing as well as proposed operations, brings about better coordination between the supplying and consuming units, and enhances the market power of the combined entity.

Concentric Diversification

Many companies seek to widen their product range by adding related products. For example, a soap manufacturer may enter the field of detergents; a scooter producer may add motorcycles to its product line; a truck manufacturer may go for passenger cars. The advantages of such diversification, referred to as concentric diversification or allied diversification, are: (i) The company could economise in the procurement of raw materials. (ii) Certain common manufacturing facilities may be better utilised. (iii) All products may benefit from the market image of the company. (iv) A common distribution network may be employed.

Conglomerate Diversification

Conglomerate diversification involves investment in fields unrelated to the existing line of business. For example, when an engineering company like Larsen and Toubro invests in shipping it is a case of conglomerate diversification. The principal motivations underlying conglomerate diversification are to (i) overcome the limited growth opportunities in the existing line of business and (ii) reduce the overall risk exposure of the firm. Many firms in India in the last two decades or so have resorted to conglomerate diversification.

Divestment

Divestment is the opposite of investment. It involves termination or liquidation of the plant or even a division of a firm. The disposal of the Chembur plant of Union Carbide to Oswal Agro is an example of divestment. The motivations for divestment may be varied: low (or even negative) profitability, declining market share, difficulty in managing, or incompatibility with corporate strategy.

Exhibit 2.2 summarises the principal motivations underlying various elementary investment strategies and their likely outcomes in terms of profitability, growth, and risk. Typically, firms pursue a combined investment strategy which reflects two or more elementary investment strategies. For example, the firm may resort to capacity expansion along with allied diversification, or it may pursue the course of vertical integration with conglomerate diversification, or it may follow the path of concentric diversification, conglomerate diversification, and vertical integration simultaneously, or it may adopt any other combination investment strategy.

EXHIBIT 2.2

Elementary Investment Strategies, Principal Motivations, and Likely Outcomes

Investment strategy	Principal motivations	Likely outcomes		
		Profitability	Growth	Risk
Replacement and modernisation	– Quality improvement – Cost reduction – Maintenance (and enhancement) of competitive power	High	Moderate	Low
Capacity expansion	– Ability to serve a growing market – Familiarity with technology and market – Cost leadership	High	Moderate	Moderate
Vertical integration	– Greater stability for existing and proposed operations – Greater market power	High	Moderate	Moderate
Concentric diversification	– Improved utilisation of resources	High	Moderate	Moderate
Conglomerate diversification	– Limited scope in the present business	Moderate	High	Low
Divestment	– Inadequate profit – Poor strategic fit	High	Low	Low

PORTFOLIO PLANNING TOOLS

To guide the process of strategic planning and resource allocation, several portfolio planning tools have been developed. Two such tools highly relevant in the context of our present discussion are:

- BCG Product Portfolio Matrix
- General Electric's Stoplight Matrix

BCG Product Portfolio Matrix

A tool for strategic (product) planning and resource allocation, the Boston Consulting Group (BCG) product portfolio matrix analyses products on the basis of (a) relative market share and (b) industry growth rate. The BCG matrix, shown in Exhibit 2.3, classifies products into four broad categories as follows:

EXHIBIT 2.3

BCG Product Portfolio Matrix

Relative Market Share

		High	Low
Industry Growth Rate	High	Stars	Question marks
	Low	Cash cows	Dogs

- *Stars* Products which enjoy a high market share and a high growth rate are referred to as stars. Though they earn high profits, they require additional commitment of funds because of the need to make further investments for expanding their production and sales. Eventually, as growth declines and additional investment needs diminish, stars become cash cows.
- *Question marks* Products with high growth potential but low present market share are called question marks. Additional resources are required to improve their market share and potentially convert them into stars. Of course, there is no guarantee that this would happen—that is why they are called 'question marks'.
- *Cash cows* Products which enjoy a relatively high market share but low growth potential are called cash cows. They generate substantial profits and cash flows but their investment requirements are modest. The cash surpluses provided by them are available for use elsewhere in the business.
- *Dogs* Products with low market share and limited growth potential are referred to as dogs. Since the prospects for such products are bleak, it is advisable to phase them out rather than continue with them.

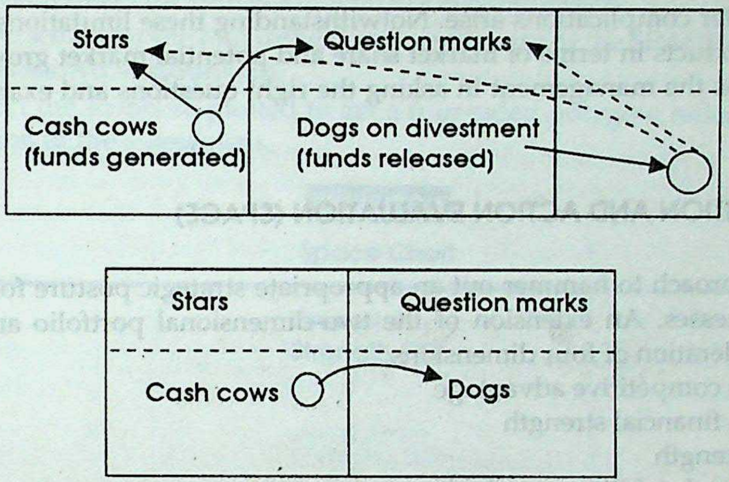
From the above description, it is broadly clear that cash cows generate funds and dogs, if divested, release funds. On the other hand, stars and question marks require further commitment of funds. Hence, the suggested pattern of resource allocation should be as shown in Part A of Exhibit 2.4. Conscious efforts should be made to avoid the pattern of resource allocation depicted in Part B of Exhibit 2.4. Some firms unwittingly adopt this pattern which leads to the neglect of stars and question marks and misdirection of surplus funds generated by cash cows into futile efforts to revive dogs.

General Electric's Stoplight Matrix

The General Electric Company of US is widely respected for the sophistication, maturity, and quality of its planning systems. The matrix developed by this company for guiding resource allocation is called the General Electric's Stoplight Matrix. It calls for analysing various products of the firm in terms of two key issues:

EXHIBIT 2.4

Pattern of Resource Allocation


Stars
Question marks
Cash cows
(funds generated)
Dogs on divestment
(funds released)
Stars
Question marks
Cash cows
Dogs

Business strength How strong is the firm vis-a-vis its competitors?

Industry attractiveness What is the attractiveness or potential of the industry?

The commitment of funds to various products is guided by how they are rated in terms of the above two dimensions. As shown in Exhibit 2.5, products which are favourably placed justify substantial commitment of funds, products which are unfavourably placed call for divestment, and products which are placed in between qualify for modest investment.

EXHIBIT 2.5

General Electric's Stoplight Matrix

Industry Attractiveness	Business strength: Strong	Average	Weak
High	Invest	Invest	Hold
Medium	Invest	Hold	Divest
Low	Hold	Divest	Divest

Evaluation

Though widely used, portfolio planning models, like the BCG matrix, tend to over-simplify the analysis of alternatives. For example, issues become more complex if the matrix is expanded to cover the possibilities of moderate market share and moderate potential market growth rate. Likewise, if factors other than profit returns and investment requirements are considered, greater complications arise. Notwithstanding these limitations, the basic idea of classifying products in terms of market share and potential market growth rate is very powerful. It helps the management in asking the right questions and examining relevant strategies.

STRATEGIC POSITION AND ACTION EVALUATION (SPACE)

SPACE is an approach to hammer out an appropriate strategic posture for a firm and its individual businesses. An extension of the two-dimensional portfolio analysis, SPACE involves a consideration of four dimensions:

- Company's competitive advantage
- Company's financial strength
- Industry strength
- Environmental stability

The factors determining competitive advantage, financial strength, industry strength, and environmental stability are shown as below:

Company's competitive advantage	**Company's financial strength**
Market share	Return on investment
Product quality	Leverage
Product life cycle	Liquidity
Product replacement cycle	Capital required/capital available
Customer loyalty	Cash flow
Competition's capacity utilisation	Ease of exit from market
Technological know-how	Risk involved in the business
Vertical integration	
Industry strength	*Environmental stability*
Growth potential	Technological changes
Profit potential	Rate of inflation
Financial stability	Demand variability
Technological know-how	Price range of competing products
Resource utilisation	Barriers to entry into market
Capital intensity	Competitive pressure
Ease of entry into market	Price elasticity of demand
Productivity, capacity utilisation	

To apply the SPACE approach to a firm, the following procedure may be followed:

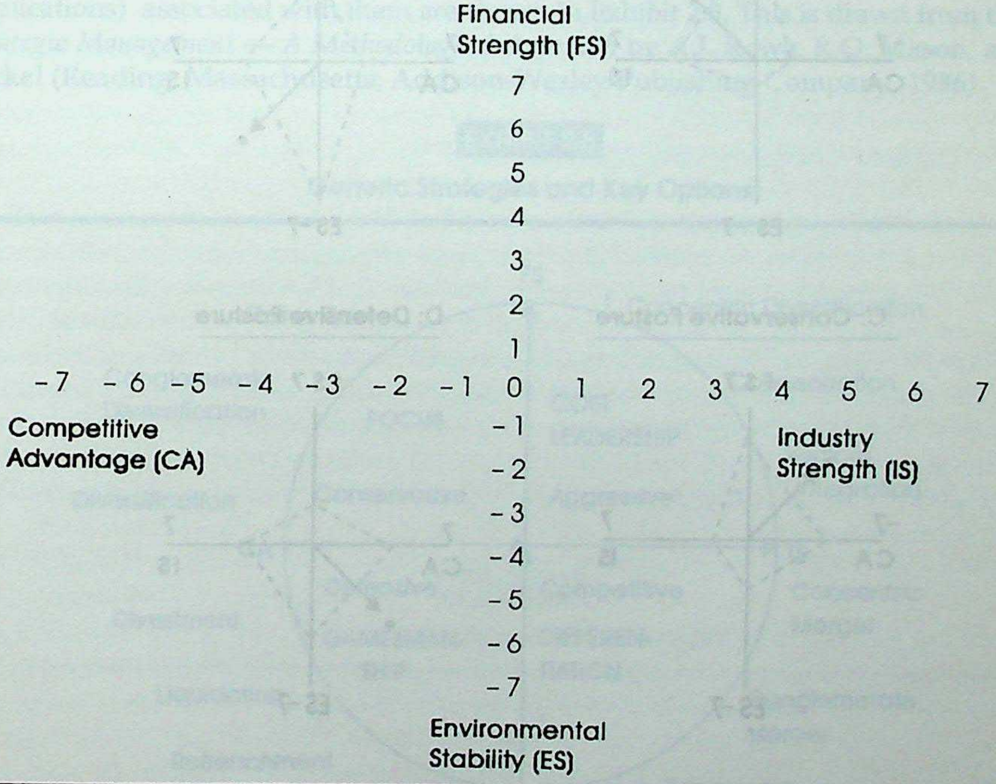
1. Numerically assess the firm on the factors which have a bearing on the four dimensions. The scale of assessment for the factors relating to the dimensions of *company's financial strength* and *industry strength* may be 0 to 7, with 0 reflecting the

most unfavourable assessment and 7 the most favourable. However, the scale of assessment for the factors relating to the dimensions of *environmental stability* and *company's competitive advantage* may be 0 to – 7, with 0 reflecting the most favourable assessment and – 7 the most unfavourable.

2. Average the numerical values assigned for various factors relating to a given dimension to get the numerical score for the dimension.
3. Plot the scores for the four dimensions on the axes of the SPACE chart. The SPACE chart is shown in Exhibit 2.6.
4. Connect the scores so plotted to get a four-sided polygon, reflecting the size and direction of the assessment.

EXHIBIT 2.6

Space Chart


Financial Strength (FS)
7
6
5
4
3
2
1
0
– 1
– 2
– 3
– 4
– 5
– 6
– 7
Environmental Stability (ES)
– 7
– 6
– 5
– 4
– 3
– 2
– 1
1
2
3
4
5
6
7
Competitive Advantage (CA)
Industry Strength (IS)

Strategic Postures

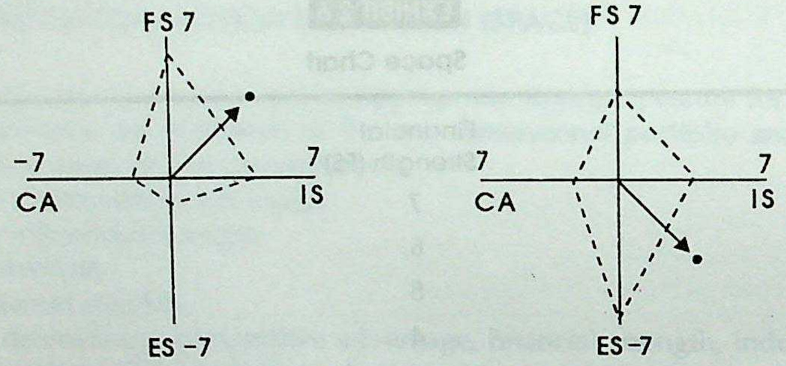
The basic strategic postures associated with the SPACE approach, illustrated graphically in Exhibit 2.7, are as follows:

Aggressive Posture This is appropriate for a company which (i) enjoys a competitive advantage and considerable financial strength and (ii) belongs to an attractive industry that operates in a relatively stable environment. An aggressive posture means that the firm must fully exploit opportunities available to it, seriously look for acquisition possibilities in its own or related industries, concentrate resources to maintain its competitive edge, and enhance its market share. The aggressive posture is similar to the generic strategy of *overall cost leadership* suggested by Michael Porter.

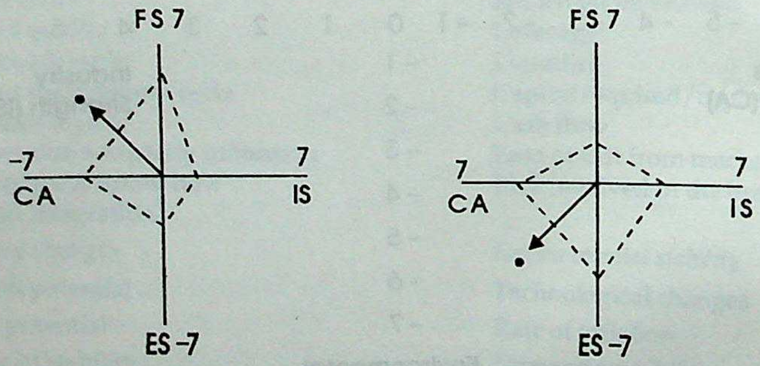
EXHIBIT 2.7

Basic Strategic Postures Associated with SPACE Approach

A: Aggressive Posture B: Competitive Posture



C: Conservative Posture D: Defensive Posture



Competitive Posture This is suitable for a company which (i) enjoys a competitive advantage but has limited financial strength and (ii) belongs to an attractive industry operating in a relatively unstable environment. The key planks of the competitive posture are as follows: maintain and enhance competitive advantage by product improvement and differentiation, widen the product line, improve marketing effectiveness, and augment financial resources. There is a great deal of commonality between the *competitive posture* described here and the generic strategy of *product differentiation* suggested by Michael Porter.

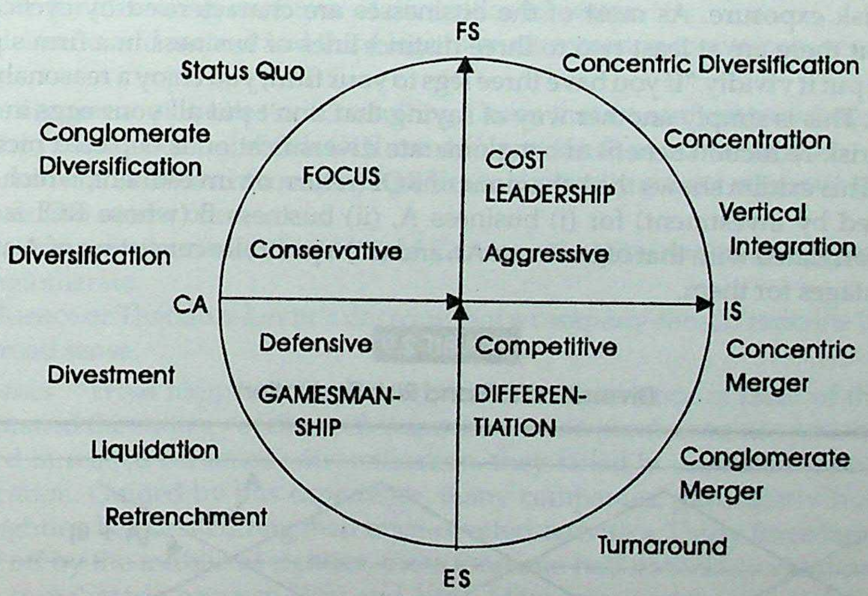
Conservative Posture This is appropriate for a company which (i) enjoys financial strength but has limited competitive advantage and (ii) belongs to a not-so-attractive industry operating in a relatively stable environment. A *conservative posture* calls for the following actions: prune non-performing products, reduce costs, improve productivity, develop new products, and access more profitable markets. The conservative posture described here is somewhat similar to the generic strategy of *focus* suggested by Michael Porter.

Defensive Posture This is suitable for a company which (i) lacks competitive advantage as well as financial strength and (ii) belongs to a not-so-attractive industry operating in an unstable environment. A defensive posture involves the following actions: discontinue unviable products, control costs aggressively, monitor cash flows strictly, reduce capacity, and postpone or limit investments. The defensive posture so defined may be likened to gamesmanship which calls for employing manoeuvres to keep the company afloat, check the onslaught of competition, and eventually facilitate withdrawal or exit.

The generic strategies and the key options (which have important resource allocation implications) associated with them are shown in Exhibit 2.8. This is drawn from the book *Strategic Management — A Methodological Approach* by A.J. Rowe, R.O. Mason, and K.E. Dickel (Reading, Massachusetts, Addison-Wesley Publishing Company, 1986).

EXHIBIT 2.8

Generic Strategies and Key Options


FS
Status Quo
Concentric Diversification
Conglomerate Diversification
Concentration
FOCUS
COST LEADERSHIP
Vertical Integration
Diversification
Conservative
Aggressive
CA
IS
Defensive
Competitive
Concentric Merger
Divestment
GAMESMANSHIP
DIFFERENTIATION
Liquidation
Conglomerate Merger
Retrenchment
Turnaround
ES

DIVERSIFICATION DEBATE

Conglomerate diversification, which involves diversification into unrelated areas, is very common in India. Here are some examples:

Company	Field of diversification
Metal Box	Ball bearings
Larsen & Toubro	Shipping
I T C	Hotel
Escorts	Dry dock
WIPRO	Computers
Bharat Vijay Mills	Syntex tanks
Oswal Agro	Petrochemicals

Despite its popularity, conglomerate diversification is considered to be a highly controversial investment strategy. This section looks at the following aspects of conglomerate diversification:

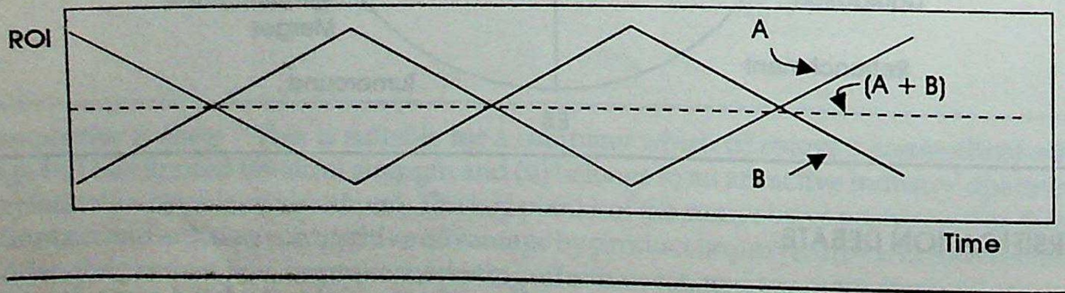
- Pros and cons of conglomerate diversification
- International experience in conglomerate diversification
- Compulsions for conglomerate diversification in India
- Guidelines for conglomerate diversification.

Pros and Cons of Conglomerate Diversification

The proponents of conglomerate diversification argue that it helps a company in reducing its overall risk exposure. As most of the businesses are characterised by cyclicality it is desirable that there are at least two to three distinct lines of business in a firm's portfolio. As someone put it vividly "If you have three legs to your firm, you enjoy a reasonable degree of stability". This is simply another way of saying that don't put all your eggs in the same basket. The risk-reduction benefit of conglomerate diversification is depicted pictorially in Exhibit 2.9. This exhibit shows the behaviour of ROI (return on investment, which is simply profit divided by investment) for (i) business A, (ii) business B (whose ROI is perfectly negatively correlated with that of business A), and (iii) a portfolio consisting of A and B with equal weightages for them.

EXHIBIT 2.9

Diversification and Risk Reduction



Another advantage claimed for conglomerate diversification is that it expands opportunities for growth. If the opportunities in the existing business are limited because of some kind of saturation, it is natural to look at other businesses where growth opportunities exist.

Typically, such opportunities are more in newly emerging industries and hence there may be a justification to diversify into these fields which may be very different from the firm's existing businesses. While the prospects of succeeding in the new line of business are often uncertain, the immense potential acts as an irresistible bait. It naturally allures firms which have strong growth-orientation. Such firms continually look for opportunities to 'widen their options' in a dynamic industrial environment.

Though a good device for reducing risk exposure and widening growth possibilities, conglomerate diversification more often than not tends to dampen average profitability. Michael Gort[2] who conducted a study for the National Bureau of Economic Research in the US found that unrelated diversification is not positively correlated with profitability. In their classic work, Peters and Waterman[3] argued that organisations which stick very close to their original business outperform others and organisations which diversify into unrelated areas tend to underperform others. Echoing a similar view, Richard Rumelt in a widely quoted research study[4] reached the following conclusion "Companies which branch out somewhat yet stick very close to their central skill, outperform all others."

International Experience in Conglomerate Diversification

In the sixties and seventies, the wave of diversification swept the industrial world in the western countries. During this period the proportion of Fortune 500 companies which were diversified or outright conglomerates increased from 50 per cent to 80 per cent. Likewise, in the US, this proportion went up from 40 per cent to 60 per cent. The factors which seemed responsible for this swing in favour of diversification were:

- A desire to add second and third legs to one's company to overcome cyclical fluctuations.
- The argument of the Boston Consulting Group that no company was safe unless it had a portfolio consisting of at least three different kinds of businesses.
- An inexorable desire of many companies to gradually get out of certain industries and move into newer ones.
- Existence of role models like Harold Geneen who presided over a gigantic corporate conglomerate.
- Influence of Theodore Levitt's doctrine that a company should redefine its business in a broad sense.

Back to Basics What happened in the eighties? The experience of most of the companies which pursued the strategy of diversification in the sixties and seventies was that while they succeeded in related (or allied) diversification, they failed in unrelated (or conglomerate) diversification. Guided by this experience, many companies, particularly from the beginning of eighties, began shedding their once-coveted activities. Thirty three large US companies sold off by the middle of eighties, more than one-half of their diversifications (via the takeover route) made between 1950 and 1980. Many companies seem to be pursuing the strategy of going *"back to basics". Here are some examples:*

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[2] Gort, Michael, *Diversification and Integration in American Industry*, Princeton, New Jersey: Princeton University Press, 1962.

[3] Peters, Thomas J. and Robert H. Waterman, Jr. *In Search of Excellence: Lessons from America's Best-run Companies*, New York: Harper and Row, 1982.

[4] Rumelt, R.P., *Strategy, Structure and Economic Performance*, Boston: Harvard Business School, 1974.

- United Biscuits has been dropping its fast food restaurants to concentrate on biscuits and food products.
- British Petroleum sold its world coal interests to concentrate on oil.
- Exxon divested Zilog, the last remnant of its decade long abortive attempt to expand in electronics.

Compulsions for Conglomerate Diversification in India

Over the last two decades or so, a large number of companies in India have invested substantially in areas different from their traditional lines of business. The factors responsible for large scale moves in unrelated areas appear to be as follows:

- Restriction in growth in the existing line of business, often arising from governmental refusal to expansion proposals.
- Vulnerability to changes in governmental policies with respect to imports, duties, pricing, and reservations.
- Opening up of newer areas of investments in the wake of liberalisation.
- Cyclicality of the main line of business leading to wide fluctuations in sales and profits from year to year.
- Bandwagon mentality which has been induced by years of close regulation of industrial activity.
- Desire to avail of tax incentives mainly in the form of investment allowance and large initial depreciation write-offs.
- A self-image of venturesomeness and versatility prodding companies to prove themselves in newer fields.
- A need to widen future options by entering newly emerging industries where the potential seems enormous.

Guidelines for Conglomerate Diversification

Conglomerate diversification, in general, dampens profitability and in some cases jeopardises the existence of the firm as it happened in the case of Metal Box. Yet there are many compulsions and inducements in India prompting companies to pursue the path of conglomerate diversification. Since it involves a journey into a relatively unfamiliar terrain it should be viewed with circumspection. Here are some practical guidelines in this respect:

1. If you lack financial sinews to sustain the new project during the 'learning period', avoid grandiose diversification projects.
2. Realistically examine whether you have the critical skills and resources to succeed in the new line of business.
3. Ensure that the diversification project has a good fit in terms of technology and market with the existing business.
4. Try to be the first or a very early entrant in the field you are diversifying into. This will protect you from serious competitive threat in the initial years.
5. Where possible adopt the following sequence: marketing—substantial sub-contracting—full blown manufacturing.
6. Seek partnership of other firms in areas where you are vulnerable or competitively weak.

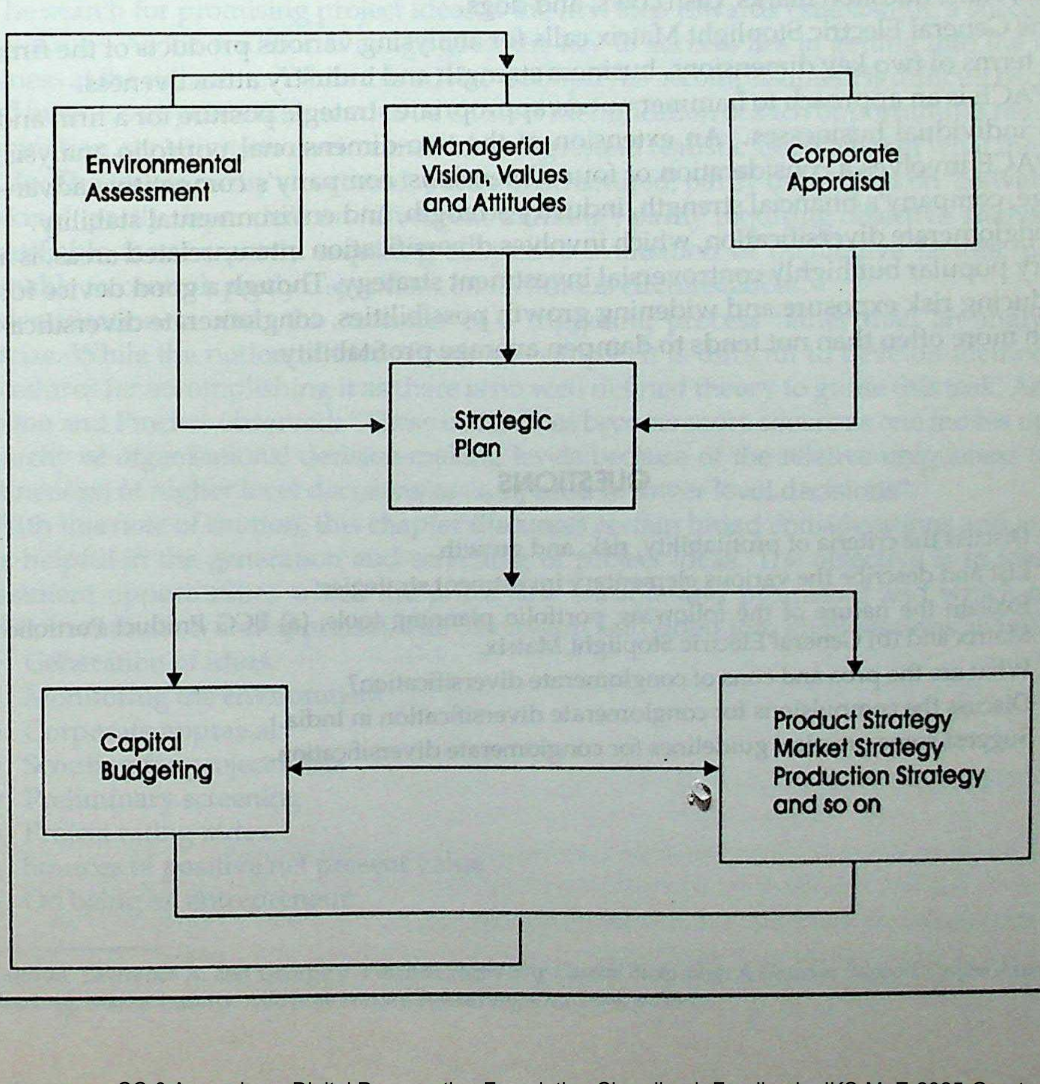
7. If the failure of the new project can threaten the company's existence, float a separate company to handle the new project.
8. Remember that meaningful conglomerate diversification represents the greatest challenge to corporate vision and leadership.
9. Guard against bandwagon mentality and empire-building tendencies.

INTERFACE BETWEEN STRATEGIC PLANNING AND CAPITAL BUDGETING

Capital expenditures, particularly the major ones, are supposed to subserve the strategy of the firm. Hence, the relationship between strategic planning and capital budgeting must be properly recognised. Exhibit 2.10 presents a way of defining this relationship. As emphasised in this exhibit, capital budgeting should be squarely related to corporate strategy.

EXHIBIT 2.10

Strategic Planning and Capital Budgeting


Environmental Assessment
Managerial Vision, Values and Attitudes
Corporate Appraisal
Strategic Plan
Capital Budgeting
Product Strategy
Market Strategy
Production Strategy
and so on

SUMMARY

- The resource allocation framework of the firm, which shapes, guides, and circumscribes individual project decisions, addresses two key issues: What should be the strategic posture of the firm? What pattern of resource allocation subserves the chosen strategic posture?
- Investment decisions, like most other business decisions, are guided by three key criteria: profitability, risk, and growth.
- The building blocks of the corporate resource allocation strategy are: replacement and modernisation, capacity expansion, vertical integration, concentric diversification, conglomerate diversification, and divestment.
- To guide the process of strategic planning and resource allocation, several portfolio planning tools have been developed. Two such tools are: (a) the BCG Product Portfolio Matrix and (b) the General Electric Stoplight Matrix.
- The BCG Product Portfolio Matrix analyses products on the basis of (a) relative market share and (b) industry growth rate. It classifies products into four broad categories, viz., stars, question marks, cash cows, and dogs.
- The General Electric Stoplight Matrix calls for analysing various products of the firm in terms of two key dimensions, business strength and industry attractiveness.
- SPACE is an approach to hammer out an appropriate strategic posture for a firm and its individual businesses. An extension of the two-dimensional portfolio analysis, SPACE involves a consideration of four dimensions: company's competitive advantage, company's financial strength, industry strength, and environmental stability.
- Conglomerate diversification, which involves diversification into unrelated areas, is a very popular but highly controversial investment strategy. Though a good device for reducing risk exposure and widening growth possibilities, conglomerate diversification more often than not tends to dampen average profitability.

QUESTIONS

1. Discuss the criteria of profitability, risk, and growth.
2. List and describe the various elementary investment strategies.
3. Explain the nature of the following portfolio planning tools: (a) BCG Product Portfolio Matrix and (b) General Electric Stoplight Matrix.
4. What are the pros and cons of conglomerate diversification?
5. Discuss the compulsions for conglomerate diversification in India.
6. Suggest some practical guidelines for conglomerate diversification.

3

Generation and Screening of Project Ideas

The search for promising project ideas is the first step towards establishing a successful venture. As the traditional adage goes, the key to success lies in getting into the right business at the right time. While this advice is simple, its accomplishment is difficult because good business opportunities tend to be elusive. Identification of such opportunities requires imagination, sensitivity to environmental changes, and realistic assessment of what the firm can do. The task is partly structured, partly unstructured; partly dependent on 'convergent thinking', partly dependent on 'divergent thinking'; partly requiring objective analysis of quantifiable factors, partly requiring subjective evaluation of qualitative factors; partly amenable to control, partly dependent on fortuitous circumstances.

Identification is often the outcome of a triggering process rather than an analytical exercise. While the notion of identification is simple, it is difficult to develop methods or procedures for accomplishing it as there is no well defined theory to guide this task. And as Gordon and Pinches observed: "These difficulties become more severe as one moves up the hierarchy of organisational decision-making levels because of the relative uniqueness (non-routineness) of higher level decisions as compared to lower level decisions".[1]

With this note of caution, this chapter discusses certain broad considerations and guidelines helpful in the generation and screening of project ideas. The objective is to identify investment opportunities which are *prima facie* feasible and promising and which merit further examination and appraisal. The discussion is divided into eight sections as follows:

- Generation of ideas
- Monitoring the environment
- Corporate appraisal
- Scouting for project ideas
- Preliminary screening
- Project rating index
- Sources of positive net present value
- On being an entrepreneur

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[1] Gordon, Lawrence A. and George E. Pinches, *Improving Capital Budgeting: A Decision Support System Approach*, Reading, Massachusetts: Addison-Wesley Publishing Co., 1984, p. 36

GENERATION OF IDEAS

Barring truly new ideas which are based on significant technological breakthroughs, most of the project ideas involve combining existing fields of technology or offering variants of present products or services. The typical route may be described as follows: Someone with specialised technical knowledge or marketing expertise or some other competence feels that he can offer a product or service which can cater to a presently unmet need or serve a market where demand exceeds supply or effectively compete with similar products or services because of certain favourable features like better quality or lower prices. His ideas are endorsed by his associates who encourage him and even show willingness to collaborate with him on the proposal. Finally he receives support from financial institutions and banks that approve his project and show readiness to finance it.

Stimulating the Flow of Ideas

Most of the firms adopt a very casual and haphazard approach to the generation of project ideas. To stimulate the flow of ideas, the following are helpful:

SWOT Analysis SWOT is an acronym for strengths, weaknesses, opportunities, and threats. SWOT analysis represents a conscious, deliberate, and systematic effort by an organisation to identify opportunities that can be profitably exploited by it. Periodic SWOT analysis facilitates the generation of ideas.

Clear Articulation of Objectives The operational objectives of a firm may be one or more of the following:

- Cost reduction
- Productivity improvement
- Increase in capacity utilisation
- Improvement in contribution margin

A clear articulation and prioritisation of objectives helps in channelising the efforts of employees and prods them to think more imaginatively.

Fostering a Conducive Climate To tap the creativity of people and to harness their entrepreneurial urges, a conducive organisational climate has to be fostered. Two conspicuous examples of organisations which have been exceptionally successful in tapping the creativity of employees are the Bell Telephone Laboratory and the 3 M Corporation. While the former has succeeded in harnessing creativity by providing an unconstrained environment the latter has effectively nurtured the entrepreneurial urges of its employees. At a more mundane level, many organisations (Hindustan Lever is a prominent example in India), have successfully used suggestion schemes to motivate employees to think more creatively.

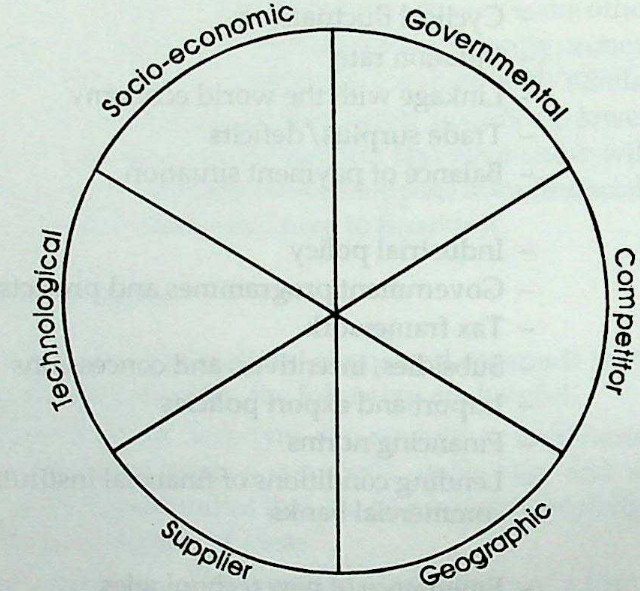
MONITORING THE ENVIRONMENT

Basically a promising investment idea enables a firm (or entrepreneur) to exploit opportunities in the environment by drawing on its competitive strengths. Hence, the firm must systematically monitor the environment and assess its competitive abilities. This section looks at the monitoring of environment and the following at corporate appraisal. For purposes of monitoring, the business environment may be divided into six broad sectors, as shown in Exhibit 3.1. The important aspects studied in monitoring the key sectors of the environment are as follows:

Economic Sector	– State of the economy – Overall rate of growth – Growth rate of primary, secondary, and tertiary sectors – Cyclical fluctuations – Inflation rate – Linkage with the world economy – Trade surplus/deficits – Balance of payment situation
Governmental Sector	– Industrial policy – Government programmes and projects – Tax framework – Subsidies, incentives, and concessions – Import and export policies – Financing norms – Lending conditions of financial institutions and commercial banks
Technological Sector	– Emergence of new technologies – Access to technical know-how, foreign as well as indigenous – Receptiveness on the part of industry
Socio-demographic Sector	– Population trends – Age shifts in population – Income distribution – Educational profile – Employment of women – Attitudes toward consumption and investment
Competition Sector	– Number of firms in the industry and the market share of the top few (four or five) – Degree of homogeneity and differentiation among products – Entry barriers – Comparison with substitutes in terms of quality, price, appeal, and functional performance – Marketing policies and practices
Supplier Sector	– Availability and cost of raw materials and sub-assemblies – Availability and cost of energy – Availability and cost of money

EXHIBIT 3.1

Business Environment


Socio-economic
Governmental
Technological
Competitor
Supplier
Geographic

CORPORATE APPRAISAL

A realistic appraisal of corporate strengths and weaknesses is essential for identifying investment opportunities which can be profitably exploited. The broad areas of corporate appraisal and the important aspects to be considered under them are as follows:

Marketing and Distribution

- Market image
- Product line
- Market share
- Distribution network
- Customer loyalty
- Marketing and distribution costs

Production and Operations

- Condition and capacity of plant and machinery
- Availability of raw materials, sub-assemblies, and power
- Degree of vertical integration
- Locational advantage
- Cost structure

Research and Development

- Research capabilities of the firm
- Track record of new product developments
- Laboratories and testing facilities
- Coordination between research and operations

Corporate Resources and Personnel

- Corporate image
- Clout with governmental and regulatory agencies
- Dynamism of top management
- Competence and commitment of employees
- State of industrial relations

Finance and Accounting

- Financial leverage and borrowing capacity
- Cost of capital
- Tax situation
- Relations with shareholders and creditors
- Accounting and control system
- Cash flows and liquidity

SCOUTING FOR PROJECT IDEAS

Good project ideas—the key to success—are elusive. So a wide variety of sources should be tapped to identify them. Here are some suggestions in this regard.

Analyse the Performance of Existing Industries A study of existing industries in terms of their profitability and capacity utilisation is helpful. The analysis of profitability and break-even level of various industries indicates promising investment opportunities—opportunities which are profitable and relatively risk-free. An examination of capacity utilisation of various industries provides information about the potential for further investment. Such a study becomes more useful if it is done region-wise, particularly for products which have high transportation costs.

Examine the Inputs and Outputs of Various Industries An analysis of the inputs required for various industries may throw up project ideas. Opportunities exist when (i) materials, purchased parts, or supplies are presently being procured from distant sources with attendant time lag and transportation costs, and (ii) several firms produce internally some components/parts which can be supplied at a lower cost by a single manufacturer who can enjoy economies of scale. Similarly, a study of the outputs of the existing industries may reveal opportunities for adding value through further processing of main outputs, by-products, as well as waste products. (Remember that one person's trash can be another person's treasure.)

Review Imports and Exports An analysis of import statistics for a period of five to seven years is helpful in understanding the trend of imports of various goods and the potential for import substitution. Indigenous manufacture of goods currently imported is advantageous for several reasons: (i) it improves the balance of payments situation, (ii) it generates employment, and (iii) it provides market for supporting industries and services. Likewise, an examination of export statistics is useful in learning about the export possibilities of various products.

Study Plan Outlays and Governmental Guidelines The government plays a very important role in our economy. Its proposed outlays in different sectors provide useful pointers toward investment opportunities. They indicate the potential demand for goods and services required by different sectors.

A very valuable source of information to estimate the scope for further investment is the *Guidelines to Industries* published annually by the Department of Industrial Development, Government of India. This publication provides information about the structure and location, production performance, licensed and installed capacity, exports, and future scope of various industries.

While the governmental projections are often a good starting point, they must be viewed with some caution. Often they are not well-grounded. It is helpful to remember the words of Alvin Hanson: "No one reading the plans can fail to be impressed by the frequent unrealism of these assumptions. So much appears to be contingent on the realisation of the unrealisable."

Look at the Suggestions of Financial Institutions and Developmental Agencies In a bid to promote development of industries in their respective states, state financial corporations, state industrial development corporations, and other developmental bodies conduct studies, prepare feasibility reports, and offer suggestions to potential entrepreneurs. The suggestions of these agencies are helpful in identifying promising projects.

Investigate Local Materials and Resources A search for project ideas may begin with an investigation into local resources and skills. Various ways of adding value to locally available materials may be examined. Similarly, the skills of local artisans may suggest products that may be profitably produced and marketed.

The National Council of Applied Economic Research (NCAER) and other bodies publish surveys of various regions showing the potential of industrial development in various regions. These surveys assess the resources (human and material), infrastructural facilities, and markets for various products.

Analyse Economic and Social Trends A study of economic and social trends is helpful in projecting demand for various goods and services. Changing economic conditions and consumer preferences provide new business opportunities. For example, a greater awareness of the value of time is dawning on the public. Hence, the demand for time-saving products like prepared food items, ovens, and powered vehicles has been increasing. Another change that can be seen is the increasing desire for leisure and recreational activities. This has caused a growth in the market for recreational products and services.

Study New Technological Developments There is a large network of research laboratories in India under the umbrella of the Council of Scientific and Industrial Research and other bodies. New products or new processes and technologies for existing products developed by research laboratories may be examined for profitable commercialisation.

Draw Clues from Consumption Abroad Entrepreneurs willing to take higher risks may identify projects for the manufacture of products or supply of services which are new to the country but extensively used abroad. Automatic vending machines, entertainment parks, pre-fabricated houses, and fast food restaurants are examples of projects belonging to this category.

Explore the Possibility of Reviving Sick Units Industrial sickness is rampant in the country. There are innumerable units which have been characterised as sick. These units are either closed or face the prospect of closure. A significant proportion of sick units, however, can be nursed back to health by sound management, infusion of further capital, and provision of complementary inputs. Hence, there is a fairly good scope for investment in this area. Such investments typically have a shorter gestation period because one does not have to begin from scratch. Indeed, in many cases, marginal efforts would suffice to revive such units.

Identify Unfulfilled Psychological Needs For well-established, multi-brand product groups like bathing soaps, detergents, cosmetics, and toothpastes, the question to be asked is not whether there is an opportunity to manufacture something to satisfy an actual physical need but whether there are certain psychological needs of consumers which are presently unfulfilled. To find out whether such an opportunity exists, the technique of spectrum analysis is useful. This analysis is done in the following manner: (i) Important factors influencing brand choice are identified. (ii) Existing brands in the market are positioned on a continuum in respect of the factors identified in step (i). (iii) Gaps which exist in relation to consumer psychological needs are identified.

Attend Trade Fairs National and international trade fairs provide an excellent opportunity to get to know about new products and developments.

Stimulate Creativity for Generating New Product Ideas New product ideas may be generated by thinking along the following lines: Modification, Rearrangement, Reversal, Magnification, Reduction, Substitution, Adaptation and Combination.

Hope that the Chance Factor will Favour You[2] Identification of investment opportunity may be influenced by the chance factor. Two examples may be given here.

- Nrupendar Rao and KVK Raju on a visit to Bokaro Steel Plant learnt that Bokaro Steel Plant was about to lose a 60,000 tonne order for hot rolled coils from a subsidiary of General Motors mainly because of sub-standard packaging. General Motors had then suggested to Bokaro managers that they use Signode packaging systems. This incident led to a plan to set up an industry to cater to packaging needs.
- Joseph Kamoo, while he was employed in Zurich, once witnessed two Moslems almost come to blows over the correct direction to face while offering their prayers. Triggered by this incident, Kamoo thought of manufacturing a Mecca-finder.

PRELIMINARY SCREENING

By using the suggestions made in the preceding section, it is possible to develop a long list of project ideas. Some kind of preliminary screening is required to eliminate ideas which prima facie are not promising. For this purpose, the following aspects may be looked into:

- Compatibility with the promoter
- Consistency with governmental priorities

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[2] This suggestion is made in a semi-humorous vein.

- Availability of inputs
- Adequacy of market
- Reasonableness of cost
- Acceptability of risk level

Compatibility with the Promoter

The idea must be compatible with the interest, personality, and resources of the entrepreneur. According to Murphy, a real opportunity has three characteristics: (i) It fits the personality of the entrepreneur—it squares with his abilities, training, and proclivities. (ii) It is accessible to him. (iii) It offers him the prospect of rapid growth and high return on invested capital.

Consistency with Governmental Priorities

The project idea must be feasible given the national goals and governmental regulatory framework. The questions to be raised in this context are:

- Is the project consistent with national goals and priorities?
- Are there any environmental effects contrary to governmental regulations?
- Can the foreign exchange requirements of the project be easily accommodated?
- Will there be any difficulty in obtaining the license for the project?

Availability of Inputs

The resources and inputs required for the project must be reasonably assured. To assess this, the following questions need to be answered:

- Are the capital requirements of the project within manageable limits?
- Can the technical know-how required for the project be obtained?
- Are the raw materials required for the project available domestically at a reasonable cost? If the raw materials have to be imported, will there be problems?
- Is the power supply for the project reasonably obtainable from external sources and captive power sources?

It may be noted here that Indian business has been traditionally faced with (i) shortages of certain inputs like power, foreign exchange, and important raw materials, and (ii) fluctuating supplies of agricultural raw materials like cotton, jute, and oil seeds.

Of course, in recent times the situation has improved in some ways: (i) power generation has increased significantly,(ii) foreign exchange is now available more easily, and (iii) supplies of certain basic industrial raw materials have been augmented substantially. However, the supply situation of power, coal, and transport facilities still leaves much to be desired.

Adequacy of the Market

The size of the present market must offer the prospect of adequate sales volume. Further, there should be a potential for growth and a reasonable return on investment. To judge the adequacy of the market the following factors have to be examined.

- Total present domestic market
- Competitors and their market shares
- Export markets
- Quality-price profile of the product vis-a-vis competitive products
- Sales and distribution system
- Projected increase in consumption
- Barriers to the entry of new units
- Economic, social, and demographic trends favourable to increased consumption
- Patent protection

It may be emphasised here that barring recessionary aberrations, the demand for most of the products in India has been growing secularly. This trend would continue because of the low levels of per capita consumption in India. Fortunately, from the point of view of entrepreneurs, the Indian economy unlike most developed, western economies, is not a 'share shift' economy wherein the growth in demand for a product is likely to be at the expense of the demand for others.

Reasonableness of Cost

The cost structure of the proposed project must enable it to realise an acceptable profit with a competitive price. The following should be examined in this regard.

- Costs of material inputs
- Labour costs
- Factory overheads
- General administration expenses
- Selling and distribution costs
- Service costs
- Economies of scale

Acceptability of Risk Level

The desirability of a project is critically dependent on the risk characterising it. In the assessment of risk—a difficult task, indeed—the following factors should be considered:

- Vulnerability to business cycles
- Technological changes
- Competition from substitutes
- Competition from imports
- Governmental control over price and distribution[3]

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[3] It may be noted here that operational controls have been imposed from time to time on business firms in India. These controls, concerned mainly with production, distribution, price, and exports, have been applied to a wide range of industries: steel, aluminium, paper, cement, fertilisers, tyres, trucks, automobiles, pharmaceuticals, textiles, bicycles, sugar, and vanaspati. The present approach of the government—it may be noted that the history of controls imposed by the government reveals a varied and chequered pattern—appears to have three main features: 1) The government is not as control-conscious as it was several years ago. This is evident from the relaxation — total or partial — of several controls in recent years. 2) The government seems to favour partial controls to total control. In many cases a part of production is being reserved to be supplied to certain sectors at a fixed, concessional price and the remaining is allowed to be sold at market price. 3) In price fixation, the government has shown a better responsiveness to inflationary forces.

PROJECT RATING INDEX

When a firm evaluates a large number of project ideas regularly, it may be helpful to streamline the process of preliminary screening. For this purpose, a preliminary evaluation may be translated into a project rating index. The steps involved in determining the project rating index are as follows:

1. Identify factors relevant for project rating.
2. Assign weights to these factors (the weights are supposed to reflect their relative importance).
3. Rate the project proposal on various factors, using a suitable rating scale. (Typically a 5-point scale or a 7-point scale is used for this purpose.)
4. For each factor multiply the factor rating with the factor weight to get the factor score.
5. Add all the factor scores to get the overall project rating index.

Exhibit 3.2 illustrates the determination of the project rating index. Once the project rating index is determined, it is compared with a pre-determined hurdle value to judge whether the project is *prima facie* worthwhile or not.

EXHIBIT 3.2

Construction of a Rating Index

Factors	*Factor Weight*	*Rating*					*Factor Score*
		VG 5	G 4	A 3	P 2	VP 1	
Input availability	0.25			✔			0.75
Technical know-how	0.10		✔				0.40
Reasonableness of cost	0.05		✔				0.20
Adequacy of market	0.15	✔					0.75
Complementary relationship with other products	0.05		✔				0.20
Stability	0.10		✔				0.40
Dependence on firm's strength	0.20	✔					1.00
Consistency with governmental priorities	0.10			✔			0.30
						Rating Index	4.00

SOURCES OF POSITIVE NET PRESENT VALUE

It is often taken for granted that there is an abundance of positive *NPV* projects which can be identified rather easily. However, note that choosing positive *NPV* projects is akin to selecting under-valued securities using fundamental analysis. The latter is possible if there are imperfections in the financial market that cause a discrepancy between security prices and their equilibrium values (intrinsic values). Likewise, imperfections in real markets (product and factor markets) lead to entry barriers which cause positive *NPVs*. Hence, an understanding of entry barriers is helpful in identifying positive *NPV* projects.

It appears that there are six main entry barriers that result in positive *NPV* projects which are as follows.

- Economies of scale
- Product differentiation
- Cost advantage
- Marketing reach
- Technological edge
- Government policy

Economies of Scale Economies of scale means that an increase in the scale of production, marketing, or distribution results in a decline in the cost per unit. When substantial economies of scale are present, the existing firms are likely to be large in size. The more pronounced the economies of scale, the greater the cost advantage of the existing firms.

In order to exploit the economies of scale, new entrants require substantial investments in plant and machinery, research and development, and market development. Such capital needs serve as an entry barrier. The greater the capital requirement, the higher the barrier to entry. This seems to be especially true in industries like petroleum refining, mineral extraction, iron and steel, and aluminium.

Product Differentiation A firm can create an entry barrier by successfully differentiating its products from those of its rivals. The basis for differentiation may be one or more of the following:

- Effective advertising and superior marketing
- Exceptional service
- Innovative product features
- High quality and dependability

Cost Advantage If a firm can enjoy cost advantage vis-a-vis its competitors, it can be reasonably assured of earning superior returns. Cost advantage may stem from one or more of the following:

- Accumulated experience and comparative edge on the learning curve
- Monopolistic access to low cost materials
- A favourable location
- More effective cost control and cost reduction

Marketing Reach A penetrating marketing reach is an important source of competitive advantage. Two examples illustrate this:

- Avon Products markets its products through a worldwide network of 900,000 independent sales representatives. Avon's competitors find it almost impossible to replicate this. Thanks to such a nonpareil marketing network, Avon has been able to earn superior returns in a highly competitive industry.
- The breadth and depth of Hindustan Lever's distribution network is miles ahead of its competitors. By 1991 end Hindustan Lever had 300,000 outlets spread over 60,000 villages, serviced by 3,000 stockists and 1,200 vans. About 4,000 salesmen supported the selling effort of 230 territory sales personnel. Such a marketing reach has contributed to the superior returns earned by Hindustan Lever.

Technological Edge Technological superiority enables a firm to enjoy excellent returns. Firms like IBM and Xerox earned superior returns over extended periods of time due to, *inter alia*, the technological edge they had over their rivals. On the Indian scene, firms like Dr. Reddy's Laboratory, Lakshmi Machine Works, and Kinetic Honda have substantially outperformed their competitors because of their technological strength.

Government Policy A government policy which shelters a firm from the onslaught of competition enables it to earn superior returns. Government policies that create entry barriers, partial or absolute, include the following:

- Restrictive licensing
- Import restrictions
- High tariff walls
- Environmental controls
- Special tax reliefs

A number of firms in India benefited substantially from restrictive government policies which offered considerable protection to them from potential competition, domestic as well as foreign, for many years. The liberalisation measures of recent years have, of course, dismantled, partly or substantially, entry barriers stemming from earlier government policies. Remember what the government can give, it can also take away.

ON BEING AN ENTREPRENEUR

What qualities and traits are required to be a successful entrepreneur? While it is difficult to answer this question definitively, it appears that a successful entrepreneur has the following qualities and traits:

- Willingness to make sacrifices
- Leadership
- Decisiveness
- Confidence in the project
- Marketing orientation
- Strong ego

Willingness to Make Sacrifices A new venture is often plagued with numerous difficulties and unanticipated problems. To nurture it in such an inhospitable environment, the entrepreneur has to be prepared to sacrifice his time, energy, and resources. He must be willing to struggle, sacrificing personal comforts and conveniences, against seemingly endless odds. An entrepreneurial job is not like a typical nine-to-five executive job. It tends to be far more demanding, requiring total commitment—and sometimes, even an obsessive preoccupation—on the part of the entrepreneur.

Leadership Successful entrepreneurs generally have strong leadership qualities. They are able to inspire ordinary persons to accomplish great feats. Even though outwardly they may show bizarre signs (they may be whimsical, timid, or even cantankerous) they are able to fire people with their zeal. They have the flair for galvanising their team to successfully cope with the challenges and frustrations inherent in a new venture.

Decisiveness A fledgling enterprise has to accomplish many things in an atmosphere of uncertainty. Numerous decisions have to be taken in quick succession on the basis of limited information. The firm does not have a history to fall back on or a well-organised data base to rely upon. Unless the entrepreneur is decisive by nature, he would not be able to cope with the enormous burden of decision making. If he procrastinates, he may court disaster. If he dilly-dallies, he may miss valuable opportunities. The fluid situation of a new enterprise calls not only for an ability to decide quickly but also an ability to revise the decisions to adapt the enterprise to an environment in which it has not established proper moorings.

Confidence in the Project An entrepreneur should have unbounded faith in his project. This helps him in instilling confidence in suppliers, creditors, customers, employees, and others. Without unflinching conviction in the project, it would be difficult for the entrepreneur to withstand the failures and frustrations that form the new venture diet.

Marketing Orientation A strong marketing orientation is critical to a new venture. An entrepreneur who is skillful in exploiting market opportunities has the best chance of success. Irrespective of the professional guise he wears (whether it be that of an engineer, inventor, production technologist, accountant, or any other), the entrepreneur must have marketing talent. Edwin Land of Polaroid is widely recognised as an ideal example of disguised marketing talent. Land, an engineering genius, had superior marketing skills and perhaps this was the most critical factor in the outstanding success of Polaroid. Land could inspire the technical and financial world, thanks to his marketing abilities. If an entrepreneur lacks marketing skills, he must find a partner who can remedy this deficiency. Otherwise the venture will be severely handicapped because of its inability to exploit the marketing opportunities.

Strong Ego Setting up a new enterprise is like riding an emotional roller coaster. There are days which bring jubilation and there are days which cause despondency, as the enterprise is buffeted by environmental forces, which tend to have a strong influence on the nascent venture. The entrepreneur needs a strong ego to bear with such ups and downs. To endure periods of adversity and to maintain proper perspective when events cast shadow over the enterprise, the entrepreneur needs a strong identity and self-image.

SUMMARY

- Identification of promising investment opportunities requires imagination, sensitivity to environmental changes, and a realistic assessment of what the firm can do.
- To stimulate the flow of investment ideas, the following are helpful: (i) SWOT analysis, (ii) clear articulation of objectives, and (iii) conducive climate.
- The business environment, which needs to be monitored regularly to identify investment opportunities, may be divided into six broad sectors: economic sector, government sector, technological sector, socio-demographic sector, competition sector, and supplier sector.
- A realistic appraisal of corporate strengths and weaknesses is essential for identifying investment opportunities which can be profitably exploited. The broad areas of corporate appraisal are: market and distribution, production and operations, research and development, corporate resources and personnel, and finance and accounting.
- Good project ideas—the key to success—are elusive. So a wide variety of sources should be tapped to identify them. Here are some suggestions in this regard: analyse the performance of existing industries, examine the inputs and outputs of various industries, review imports and exports, study plan outlays and governmental guidelines,

look at the suggestions of financial institutions and developmental agencies, investigate local materials and resources, analyse economic and social trends, study new technological developments, draw clues from consumption abroad, explore the possibility of reviving sick units, identify unfulfilled psychological needs, attend trade fairs, stimulate creativity for generating new product ideas, and hope that the chance factor will favour you.

- By using the above suggestions, it is possible to develop a long list of project ideas. For the preliminary screening of these ideas, the following aspects may be looked into: compatibility with the promoter, consistency with governmental priorities, availability of inputs, adequacy of market, reasonableness of cost, and acceptability of risk level. When a firm evaluates a large number of project ideas regularly, it may he helpful to streamline the process of preliminary screening by employing a project rating index.
- It appears that there are six main entry barriers which result in positive *NPV* projects: economies of scale, product differentiation, cost advantage, marketing reach, technological edge, and government policy.
- It appears that a successful entrepreneur has the following qualities and traits: willingness to make sacrifices, leadership, decisiveness, confidence in the project, marketing orientation, and strong ego.

QUESTIONS

1. What can a firm do to stimulate the flow of project ideas?
2. Describe briefly the aspects of business environment that need to be monitored as well as the dimensions along which a firm may appraise its strengths and weaknesses for identifying investment opportunities.
3. Discuss suggestions helpful in scouting for project ideas.
4. What key issues would you examine in a preliminary screening exercise?
5. Discuss how a project rating index may be developed.
6. What qualities and traits are required to be a successful entrepreneur?
7. Discuss the sources of positive *NPV*.

APPENDIX 3A

PROFIT POTENTIAL OF INDUSTRIES: PORTER MODEL

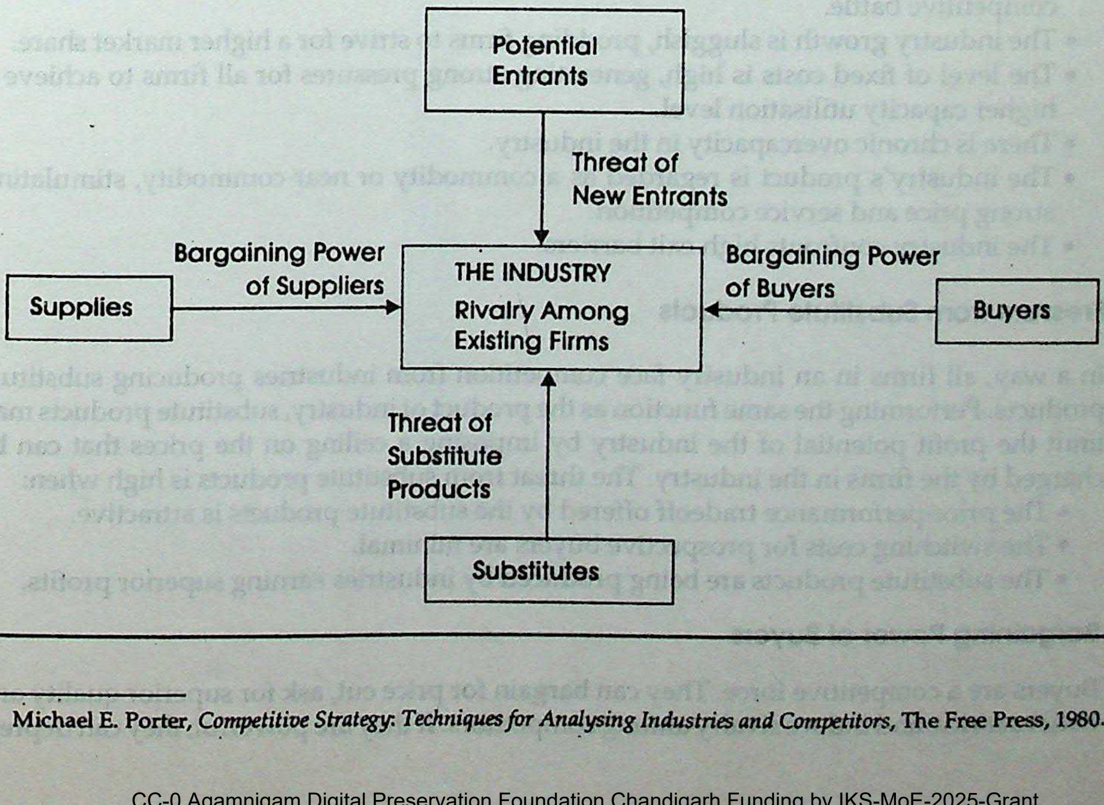
Michael Porter[1] has argued that the profit potential of an industry depends on the combined strength of the following five basic competitive forces:

- Threat of new entrants
- Rivalry among existing firms
- Pressure from substitute products
- Bargaining power of buyers
- Bargaining power of sellers

Exhibit 3A.1 shows diagrammatically the forces that drive competition and determine industry profit potential.

EXHIBIT 3A.1

Forces Driving Industry Competition


Potential Entrants
Threat of New Entrants
Bargaining Power of Suppliers
Supplies
THE INDUSTRY
Rivalry Among Existing Firms
Bargaining Power of Buyers
Buyers
Threat of Substitute Products
Substitutes

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[1] Michael E. Porter, *Competitive Strategy: Techniques for Analysing Industries and Competitors*, The Free Press, 1980.

Threat of New Entrants

New entrants add capacity, inflate costs, push prices down, and reduce profitability. Hence, if an industry faces the threat of new entrants, its profit potential would be limited. The threat from new entrants is low if the entry barriers confer an advantage on existing firms and deter new entrants. Entry barriers are high when:

- The new entrants have to invest substantial resources to enter the industry.
- Economies of scale are enjoyed by the industry.
- Existing firms control the distribution channels, benefit from product differentiation in the form of brand image and customer loyalty, and enjoy some kind of proprietary experience curve.
- Switching costs—these are essentially one-time costs of switching from the products of one supplier to another—are high.
- The government policy limits or even prevents new entrants.

Rivalry Between Existing Firms

Firms in an industry compete on the basis of price, quality, promotion, service, warranties, and so on. Generally, a firm's attempts to improve its competitive position provoke retaliatory action from others. If the rivalry between the firms in an industry is strong, competitive moves and countermoves dampen the average profitability of the industry. The intensity of rivalry in an industry tends to be high when:

- The number of competitors in the industry is large.
- At least a few firms are relatively balanced and capable of engaging in a sustained competitive battle.
- The industry growth is sluggish, prodding firms to strive for a higher market share.
- The level of fixed costs is high, generating strong pressures for all firms to achieve a higher capacity utilisation level.
- There is chronic overcapacity in the industry.
- The industry's product is regarded as a commodity or near-commodity, stimulating strong price and service competition.
- The industry confronts high exit barriers.

Pressure from Substitute Products

In a way, all firms in an industry face competition from industries producing substitute products. Performing the same function as the product of industry, substitute products may limit the profit potential of the industry by imposing a ceiling on the prices that can be charged by the firms in the industry. The threat from substitute products is high when:

- The price-performance tradeoff offered by the substitute products is attractive.
- The switching costs for prospective buyers are minimal.
- The substitute products are being produced by industries earning superior profits.

Bargaining Power of Buyers

Buyers are a competitive force. They can bargain for price cut, ask for superior quality and better service, and induce rivalry among competitors. If they are powerful, they can depress the profitability of the supplier industry. The bargaining power of a buyer group is high when:

- Its purchases are large relative to the sales of the seller.
- Its switching costs are low.
- It poses a strong threat of backward integration.

Bargaining Power of Suppliers

Suppliers, like buyers, can exert a competitive force in an industry as they can raise prices, lower quality, and curtail the range of free services they provide. Powerful suppliers can hurt the profitability of the buyer industry. Suppliers have strong bargaining power when:

- Few suppliers dominate and the supplier group is more concentrated than the buyer group.
- There are hardly any viable substitutes for the products supplied.
- The switching costs for the buyers are high.
- Suppliers do present a real threat of forward integration.

PART 2

ANALYSIS

Market and Demand Analysis

Technical Analysis

Financial Analysis

4

Market and Demand Analysis

In most cases, the first step in project analysis is to estimate the potential size of the market for the product proposed to be manufactured (or service planned to be offered) and get an idea about the market share that is likely to be captured. Put differently, market and demand analysis is concerned with two broad issues: What is the likely aggregate demand for the product/service? What share of the market will the proposed project enjoy?

These are very important, yet difficult, questions in project analysis. Intelligent and meaningful answers to them call for an in-depth study and assessment of various factors like patterns of consumption growth, income and price elasticity of demand, composition of the market, nature of competition, availability of substitutes, reach of distribution channels, so on and so forth. Yet, in many cases project feasibility studies seem to make a short shrift of market and demand analysis. It is not uncommon to find cursory statements like "the market is attractive" or "the demand is expected to exceed supply" as substitutes for a thorough market and demand analysis in project evaluation exercises.

Given the importance of market and demand analysis, it should be carried out in an orderly and systematic manner. The key steps in such analysis are as follows:

- Situational analysis and specification of objectives
- Collection of secondary information
- Conduct of market survey
- Characterisation of the market
- Demand forecasting
- Market planning

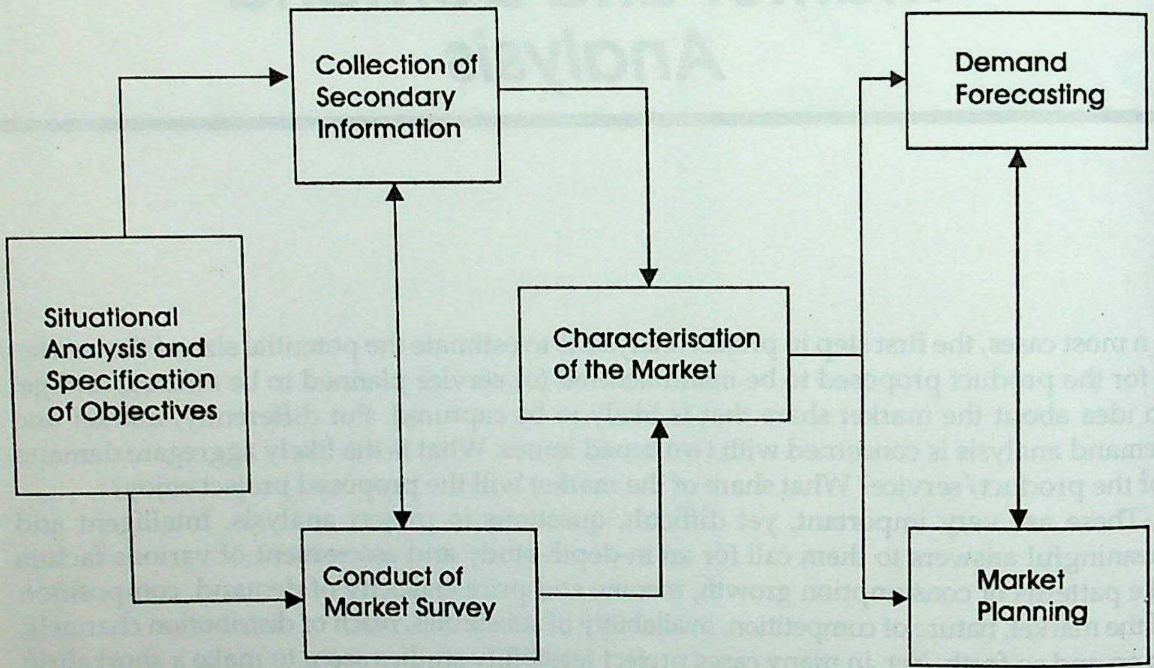
This chapter discusses these steps in detail. Exhibit 4.1 depicts how these steps are broadly inter-related.

SITUATIONAL ANALYSIS AND SPECIFICATION OF OBJECTIVES

In order to get a "feel" for the relationship between the product and its market, the project analyst may informally talk to customers, competitors, middlemen, and others in the industry. Wherever possible, he may look at the experience of the company to learn about the preferences and purchasing power of customers, actions and strategies of competitors and practices of the middlemen.

EXHIBIT 4.1

Key Steps in Market and Demand Analysis and their Inter-relationship


Collection of Secondary Information
Demand Forecasting
Situational Analysis and Specification of Objectives
Characterisation of the Market
Conduct of Market Survey
Market Planning

If such a situational analysis generates enough data to measure the market and get a reliable handle over projected demand and revenues, a formal study need not be carried out, particularly when cost and time considerations so suggest. In most cases, of course, a formal study of market and demand is warranted. To carry out such a study, it is necessary to spell out its objectives clearly and comprehensively. Often this means that the intuitive and informal goals that guide situational analysis need to be expanded and articulated with greater clarity. A helpful approach to spell out objectives is to structure them in the form of questions. Of course, in doing so, always bear in mind how the information generated will be relevant in forecasting the overall market demand and assessing the share of the market the project will capture. This will ensure that questions not relevant to market and demand analysis will not be asked unnecessarily.

To illustrate, suppose that a small but technologically competent firm has developed an improved air cooler based on a new principle that appears to offer several advantages over the conventional air cooler. The chief executive of the firm needs information about where and how to market the new air cooler. The objectives of market and demand analysis in this case may be to answer the following questions:

- Who are the buyers of air coolers?
- What is the total current demand for air coolers?

- How is the demand distributed temporally (pattern of sales over the year) and geographically?
- What is the break-up of demand for air coolers of different sizes?
- What price will the customers be willing to pay for the improved air cooler?
- How can potential customers be convinced about the superiority of the new cooler?
- What price and warranty will ensure its acceptance?
- What channels of distribution are most suited for the air cooler? What trade margins will induce distributors to carry it?
- What are the prospects of immediate sales?

COLLECTION OF SECONDARY INFORMATION

In order to answer the questions listed while delineating the objectives of the market study, information may be obtained from secondary and/or primary sources. Secondary information is information that has been gathered in some other context and is already available. Primary information, on the other hand, represents information that is collected for the first time to meet the specific purpose on hand. Secondary information provides the base and the starting point for market and demand analysis. It indicates what is known and often provides leads and cues for gathering primary information required for further analysis. This section looks at the secondary information and the following at the primary information.

General Sources of Secondary Information

The important sources of secondary information useful for market and demand analysis in India are mentioned below:

Census of India A decennial publication of the Government of India, it provides, *inter alia*, information on population, demographic characteristics, household size and composition, and maps.

National Sample Survey Reports Issued from time to time by the Cabinet Secretariat, Government of India, these reports present information on various economic and social aspects like patterns of consumption, distribution of households by the size of consumer expenditure, distribution of industries, and characteristics of the economically active population. The information presented in these reports is obtained from a nationally representative sample by the interview method.

Plan Reports Issued by the Planning Commission usually at the beginning, middle, and end of the five-year plans, these reports and documents provide a wealth of information on plan proposals, physical and financial targets, actual outlays, accomplishments, etc.

Statistical Abstract of the Indian Union An annual publication of the Central Statistical Organisation, it provides, *inter alia*, demographic information, estimates of national income, and agricultural and industrial statistics.

India Year Book An annual publication of the Ministry of Information and Broadcasting, it provides a wide range of information on economic and other aspects.

Statistical Year Book An annual publication of the United Nations, it provides world statistics relating to various aspects like population, demography, gross domestic publication, industrial production, international trade, etc.

Economic Survey An annual publication of the Ministry of Finance, it provides the latest data on industrial production, wholesale prices, consumer prices, exports, agricultural production, national income, etc.

Guidelines to Industries This is an annual publication of the Ministry of Industrial Development.

Annual Survey of Industries An annual publication of the Central Statistical Organisation, it contains information on various aspects of industry: number of units and state-wise distribution, average number of working days, employment, materials consumption, quantity of products, etc.

Annual Reports of the Development Wing, Ministry of Commerce and Industry An annual publication, it gives a detailed review of industries under the purview of the wing. It also provides information about new items manufactured for the first time in India and the list of protected industries.

Annual Bulletin of Statistics of Exports and Imports An annual publication of the Ministry of Commerce, it provides data on imports and exports for a very large number of items and as per international classification.

Techno-Economic Surveys The National Council of Applied Economic Research has conducted and published techno-economic surveys for various states.

Industry Potential Surveys The Industrial Development Bank of India in consortium with other financial institutions has conducted and published industrial potential surveys for several backward areas.

The Stock Exchange Directory This directory, published by the Bombay Stock Exchange, provides a ten-year picture of performance and financial statements for all listed companies and other important companies. It contains very valuable information for comparative analysis. It is periodically updated.

Monthly Studies of Production of Selected Industries A monthly publication of the Central Statistical Organisation, it provides all-India data on production, number of units installed, capacity, state-wise break-up, stock level, etc., for several selected industries.

Monthly Bulletin of Reserve Bank of India This provides information on production indices, prices, balance of payment position, exchange rates, etc.

Publications of Advertising Agencies The leading advertising agencies like Clarion, McCann and Thompson have published test markets, marketing rating indices of towns of India, consumer index of markets, and other studies which throw valuable light on Indian markets.

Other Publications Among other publications, mention may be made of the following: (i) *Weekly Bulletin of Industrial Licenses, Import Licenses and Export Licenses* (published by the Government of India); (ii) Studies of the economic division of the State Trading Corporation; (iii) Commodity reports and other studies of the Indian Institute of Foreign Trade; (iv) Studies and reports of export promotion councils and commodity boards; and (v) *Annual Report on Currency and Finance* (issued by the Reserve Bank of India).

Industry Specific Sources of Secondary Information

The important industry-specific sources of secondary information are given in Exhibit 4.2.

EXHIBIT 4.2

Some Important Industry-Specific Sources of Secondary Information

Industry	Title	Publisher
Automobiles	*Annual Reports of Association of Indian Automobile Manufacturers*	Indian Automobile Manufacturers Association, Army and Navy Bldg., Mahatma Gandhi Road, Bombay 23
	Automobile Ancillary Industry (Yearly)	All-India Automobile and Ancillary Industries Association, 80, Dr. Annie Besant Road, Bombay 18
Chemicals (including Fertilisers, Drugs and Pharmaceuticals)	*Fertiliser Statistics*	Fertiliser Association of India, Near JN University, New Delhi 57
	Annual Reports of Organisation of Pharmaceutical Producers of India	Organisation of Pharmaceutical Producers of India, Cook's Building, DN road, Bombay 1
	Indian Drugs and Pharmaceutical Industries	Chary Publications, 18B, Bharucha Marg, Bombay 43
	Chemical Age of India	Technical Press Publications, 5 Convent Street, Bombay 1
Electrical and Electronics	*Annual Electric Power Survey of India*	Central Electricity Authority, Government of India
	Annual Report of Indian Electrical Manufacturers Association	Indian Electrical Manufacturers Association, Hakad Chambers, Dr. A. Besant Road Bombay 18
	Electric India (Fortnightly)	Indian Electrical Manufacturers Association, Hakad Chambers, Dr. A. Besant Road Bombay 18
	Electronic Digest	All-India Radio and Electronics Association, Sukh Sagar, NS Patkar Marg, Bombay 7
	Electronics Information and Planning (Monthly)	Information, Planning and Analysis Group of Electronics Commission, New Delhi
Industrial Machinery	*Build Machine-Build India*	Directorate General of Technical Development
	Textile Machinery Accessories and Stores Journal	Chary Publications, 18B, Bharucha Marg Bombay 43
	Annual Report of Indian Machine Tool Manufacturers Association	Indian Machine Tool Manufacturers Association, 82 Jolly Maker Chambers, No. 2, 225 Nariman Point, Bombay 21
Metallurgical	*Iron and Steel Control Bulletin*(Quarterly)	Ministry of Steel and Mines
	Steel Furnace (Monthly)	Steel Furnace Association of India, 3/D, Vandana, 11 Tolstoy Marg, New Delhi 1

Industry	Title	Publisher
	Annual Reports of Steel Wire Manufacturers Association of India	Steel Wire Manufacturers Association of India, 6 N. Subhas Road, Calcutta 1
	Minerals and Metals Review	Asian Industry and Information Services (P) Ltd. Calcutta
	Annual Reports of Steel Re-rolling Mills Association	Steel Re-rolling Mills Association, C-50, Anand Niketan, New Delhi 23
Textiles	*Indian Textile Bulletin*	Textile Commissioner, Bombay
	Silk and Rayon Industries of India	Silk and Art Silk Mills' Research Association, Dr. A. Besant Road, Bombay 18
	Wool and Woollens of India	Indian Woollen Mills' Federation, Churchgate Chambers, 4 New Marine Lines, Bombay 20
	Man-made Fibres	Association of Man-made Fibre Industry, 78, Veer Nariman Road, Bombay 20
	Synthetic Fibre	Association of Synthetic Fibre Industry, Raj Mahal, 84 Veer Nariman Road, Bombay 20
	Jute Chronicle	Indian Jute Mills Association, Royal Exchange, 9 N. Subhas Road, Calcutta 1
	Monthly Summary of Jute and Gunny Statistics	Indian Jute Mills Association, Royal Exchange, 9 N Subhas Road, Calcutta 1
	Annual Reports of Indian Cotton Mills Federation	Indian Cotton Mills Federation, 34, P.D. Mello Road, Wadi Bunder, Bombay 9
Other Industries	*Cement*	Cement Manufacturers Association, Express Building, Opp. Churchgate Rly Station Bombay 20
	Glass Udyog	All-India Glass Manufacturers Federation, 812 ND House, Barakhamba Road, New Delhi 1
	Hotel Guide-India	Federation of Hotel and Restaurant Association of India, 503/56, Nehru Place, New Delhi 24
	Indian Packaging Directory	Indian Institute of Packaging, E-2, Marol Industrial Estate, Bombay 93
	Packaging India (Quarterly)	Indian Institute of Packaging, E-2, Marol Industrial Estate, Bombay 93
	Rubber India	All-India Rubber Industries Association, Navjivan Society Building, Lamington Road, Bombay 8
	Statistics of Marine Products Exports	Marine Products Export Development Authority, M. Gandhi Road, Cochin 16
	Yearbook of Fishery Statistics	FAO, United Nations Organisation

Evaluation of Secondary Information

While secondary information is available economically and readily (provided the market analyst is able to locate it) its reliability, accuracy, and relevance for the purpose under consideration must be carefully examined. The market analyst should seek to know:

- Who gathered the information? What was the objective?
- When was the information gathered? When was it published?
- How representative was the period for which the information was gathered?
- Have the terms in the study been carefully and unambiguously defined?
- What was the target population?
- How was the sample chosen?
- How representative was the sample?
- How satisfactory was the process of information gathering?
- What was the degree of sampling bias and non-response bias in the information gathered?
- What was the degree of misrepresentation by respondents?
- How accurately was the information edited, tabulated, and analysed?
- Was statistical analysis properly applied?

CONDUCT OF MARKET SURVEY

Secondary information, though useful, often does not provide a comprehensive basis for market and demand analysis. It needs to be supplemented with primary information gathered through a market survey, specific to the project being appraised.

The market survey may be a census survey or a sample survey. In a census survey the entire population is covered. (The word 'population' is used here in a particular sense. It refers to the totality of all units under consideration in a specific study. Examples are: all industries using milling machines, all readers of the *Economic Times*.) Census surveys are employed principally for intermediate goods and investment goods when such goods are used by a small number of firms. In other cases, a census survey is prohibitively costly and may also be infeasible. For example, it would be inordinately expensive—nay,impossible—to cover every user of Lifebuoy or every person in the income bracket Rs 10,000 - Rs 15,000.

Due to the above mentioned limitations of the census survey, the market survey, in practice, is typically a sample survey. In such a survey a sample of the population is contacted/observed and relevant information is gathered. On the basis of such information, inferences about the population may be drawn.

The information sought in a market survey may relate to one or more of the following:

- Total demand and rate of growth of demand
- Demand in different segments of the market
- Income and price elasticities of demand
- Motives for buying
- Purchasing plans and intentions
- Satisfaction with existing products
- Unsatisfied needs
- Attitudes toward various products

- Distributive trade practices and preferences
- Socio-economic characteristics of buyers

Steps in a Sample Survey

Typically, a sample survey consists of the following steps:

1. *Define the Target Population*

In defining the target population the important terms should be carefully and unambiguously defined. The target population may be divided into various segments which may have differing characteristics. For example, all television owners may be divided into three to four income brackets.

2. *Select the Sampling Scheme and Sample Size*

There are several sampling schemes: simple random sampling, cluster sampling, sequential sampling, stratified sampling, systematic sampling, and non-probability sampling. Each scheme has its advantages and limitations. The sample size, other things being equal, has a bearing on the reliability of the estimates—the larger the sample size, the greater the reliability.

3. *Develop the Questionnaire*

The questionnaire is the principal instrument for eliciting information from the sample of the respondents. The effectiveness of the questionnaire as a device for eliciting the desired information depends on its length, the types of questions, and the wording of questions. Developing the questionnaire requires a thorough understanding of the product/service and its usage, imagination, insights into human behaviour, appreciation of subtle linguistic nuances, and familiarity with the tools of descriptive and inferential statistics to be used later for analysis. It also requires knowledge of psychological scaling techniques if the same are employed for obtaining information relating to attitudes, motivations, and psychological traits. Industry and trade market surveys, in comparison to consumer surveys, generally involve more technical and specialised questions.

Since the quality of the questionnaire has an important bearing on the results of market survey, the questionnaire should be tried out in a pilot survey and modified in the light of problems/difficulties noted.

4. *Recruit and Train the Field Investigators*

Recruiting and training of field investigators must be planned well since it can be time-consuming. Great care must be taken for recruiting the right kind of investigators and imparting the proper kind of training to them. Investigators involved in industry and trade market survey need intimate knowledge of the product and technical background particularly for products based on sophisticated technologies.

5. *Obtain Information as per the Questionnaire from the Sample of Respondents*

Respondents may be interviewed personally, telephonically, or by mail for obtaining information. Personal interviews ensure a high rate of response. They are, however, expensive and likely to result in biased responses because of the presence of the interviewer. Mail surveys are economical and evoke fairly candid responses. The response rate, however, is often low. Telephonic interviews, common in western countries, have very limited applicability in India because telephone tariffs are high and telephone connections few.

6. *Scrutinise the Information Gathered*

Information gathered should be thoroughly scrutinised to eliminate data which is internally inconsistent and which is of dubious validity. For example, a respondent with a high income and large family may say that he lives in a one-room tenement. Such information, probably inaccurate, should be deleted. Sometimes data inconsistencies may be revealed only after some analysis.

7. *Analyse and Interpret the Information*

Information gathered in the survey needs to be analysed and interpreted with care and imagination. After tabulating it as per a plan of analysis, suitable statistical investigation may be conducted, wherever possible and necessary. For purposes of statistical analysis, a variety of methods are available. They may be divided into two broad categories: parametric methods and non-parametric methods. Parametric methods assume that the variable or attribute under study conforms to some known distribution. Non-parametric methods do not presuppose any particular distribution.

Results of data based on sample survey will have to be extrapolated to the target population. For this purpose, appropriate inflationary factors, based on the ratio of the size of the target population to the size of the sample studied, will have to be used.

The statistical analysis of data should be directed by a person who has a good background in statistics as well as economics.

It may be emphasised that the results of the market survey can be vitiated by: (i) non-representativeness of the sample, (ii) imprecision and inadequacies in the questions, (iii) failure of the respondents to comprehend the questions, (iv) deliberate distortions in the answers given by the respondents, (v) inept handling of the interviews by the investigators, (vi) cheating on the part of the investigators, (vii) slip-shod scrutiny of data, and (viii) incorrect and inappropriate analysis and interpretation of data.

Some Problems

A market researcher in India has to contend with the following problems:

Heterogeneity of the Country Since it is well-nigh impossible to cover all the states in an all-India survey, the country has to be divided into broad territories going beyond the state boundaries. However, the heterogeneity of the country makes the task difficult. Presently the research agencies seem to divide the country the way they think it is appropriate. This causes problems in comparing the findings of different research agencies.

Multiplicity of Languages Related to the above difficulty is the problem of multiplicity of languages confronted by a research agency interested in conducting an all-India survey.

Design of Questionnaire Scaling techniques, commonly recommended in marketing research literature, involve a 5-point scale or a 7-point scale. Such refined scales are not easily amenable to translation in regional languages. More important, they are often not comprehensible to a vast majority of respondents who may lack the education and sophistication to understand them. Hence when refined scaling techniques are used, answers tend to be erratic and inconsistent. It is perhaps desirable to rely more on open-ended questions and less on pre-coded questions on definite scales.

CHARACTERISATION OF THE MARKET

Based on the information gathered from secondary sources and through the market survey, the market for the product/service may be described in terms of the following:

- Effective demand in the past and present
- Breakdown of demand
- Price
- Methods of distribution and sales promotion
- Consumers
- Supply and competition
- Government policy

Effective Demand in the Past and Present

To gauge the effective demand in the past and present, the starting point typically is apparent consumption which is defined as:

Production + Imports – Exports – Changes in stock level

The figure of apparent consumption has to be adjusted for consumption of the product by the producers and the effect of abnormal factors. The consumption series, after such adjustments, may be obtained for several years.

In a competitive market, effective demand and apparent consumption are equal. However, in most of the developing countries, where competitive markets do not exist for a variety of products due to exchange restrictions and controls on production and distribution, the figure of apparent consumption may have to be adjusted for market imperfections. Admittedly, this is often a difficult task.

Breakdown of Demand

To get a deeper insight into the nature of demand, the aggregate (total) market demand may be broken down into demand for different segments of the market. Market segments may be defined by (i) nature of product, (ii) consumer group, and (iii) geographical division.

Nature of Product One generic name often subsumes many different products: steel covers sections, rolled products, and various semi-finished products; commercial vehicles cover trucks and buses of various capacities; so on and so forth.

Consumer Groups Consumers of a product may be divided into industrial consumers and domestic consumers. Industrial consumers may be sub-divided industrywise. Domestic consumers may be further divided into different income groups.

Geographical Division A geographical breakdown of consumers, particularly for products which have a small value-to-weight relationship and products which require regular, efficient after-sales service is helpful.

Why is segmental analysis required? Segmental information is helpful because the nature of demand tends to vary from one segment to another (the demand from consumers in high income brackets may not be sensitive to price variations whereas the demand from consumers in low income brackets may be very sensitive to price variations) and different marketing strategies may be appropriate to different market segments.

Price

Price statistics must be gathered along with statistics pertaining to physical quantities. It may be helpful to distinguish the following types of prices: (i) manufacturer's price quoted as FOB (free on board) price or CIF (cost, insurance, and freight) price, (ii) landed price for imported goods, (iii) average wholesale price, and (iv) average retail price.

Methods of Distribution and Sales Promotion

The method of distribution may vary with the nature of product. Capital goods, industrial raw materials or intermediates, and consumer products tend to have differing distribution channels. Further, for a given product, distribution methods may vary. Likewise, methods used for sales promotion (advertising, discounts, gift schemes, etc.) may vary from product to product.

The methods of distribution and sales promotion employed presently and their rationale must be specified. Such a study may explain certain patterns of consumption and highlight the difficulties that may be encountered in marketing the proposed products.

Consumers

Consumers may be characterised along two dimensions as follows:

Demographic and sociological	Attitudinal
Age	Preferences
Sex	Intentions
Income	Habits
Profession	Attitudes
Residence	Responses
Social background	

Supply and Competition

It is necessary to know the existing sources of supply and whether they are foreign or domestic. For domestic sources of supply, information along the following lines may be gathered: location, present production capacity, planned expansion, capacity utilisation level, bottlenecks in production, and cost structure.

Competition from substitutes and near-substitutes should be specified because almost any product may be replaced by some other product as a result of relative changes in price, quality, availability, promotional effort, and so on.

Government Policy

The role of government in influencing the demand and market for a product may be significant. Governmental plans, policies, legislations, and fiats which have a bearing on the market and demand of the product under examination should be spelt out. These are reflected in: production targets in national plans, import and export trade controls, import duties, export incentives, excise duties, sales tax, industrial licensing, preferential purchases, credit controls, financial regulations, and subsidies/penalties of various kinds.

DEMAND FORECASTING

After gathering information about various aspects of the market and demand from primary and secondary sources, an attempt may be made to estimate future demand. A wide range of forecasting methods is available to the market analyst. These may be divided into three categories : qualitative methods, time series projection methods, and causal methods. A brief description of these methods follow. For a more detailed exposition, consult Appendix 4A at the end of this chapter.

Qualitative Methods

These methods rely essentially on the judgement of experts to translate qualitative information into quantitative estimates. The important qualitative methods are as follows.

- *Jury of executive opinion method* Very popular in practice, this method calls for the pooling of views of a group of executives on expected future sales and combining them into a sales estimate.
- *Delphi method* This method involves converting the views of a group of experts, who do not interact face-to-face, into a forecast through an iterative process.

Time Series Projection Methods

These methods generate forecasts on the basis of an analysis of the historical time series. The important time series projection methods are as follows:

- *Trend projection method* Very popular in practice, the trend projection method involves extrapolating the past trend onto the future.
- *Exponential smoothing method* In exponential smoothing, forecasts are modified in the light of observed errors.
- *Moving average method* According to this method, the forecast for the next period represents a simple arithmetic average or a weighted arithmetic average of the last few observations.

Causal Methods

More analytical than the preceding methods, causal methods seek to develop forecasts on the basis of cause-effect relationships specified in an explicit, quantitative manner. The important methods under this category are as follows:

- *Chain ratio method* A simple analytical approach, this method calls for applying a series of factors for developing a demand forecast.
- *Consumption level method* Useful for a product that is directly consumed, this method estimates consumption level on the basis of elasticity coefficients, the important ones being the income elasticity of demand and the price elasticity of demand.
- *End use method* Suitable for intermediate products, the end use method develops demand forecasts on the basis of the consumption coefficient of the product for various uses.
- *Leading indicator method* According to this method, observed changes in leading indicators are used to predict the changes in lagging variables.

- *Econometric method* Perhaps the most sophisticated forecasting tool, the econometric method involves estimating quantitative relationship derived from economic theory.

MARKET PLANNING

To enable the product to reach a desired level of market penetration, a suitable marketing plan should be developed. Broadly, it should cover pricing, distribution, promotion, and service. The details that need to be hammered out are shown below:

Pricing	Distribution
Ex-factory price	Packaging
Taxes and duties applicable for the domestic price	Transportation arrangements
Trade margins/ discounts	Channel of distribution
Final price to the domestic customer	Role of distributors, wholesalers, and retailers
Export price	

Promotion	Service
Branding	Installation
Advertising	User education
Personal selling	Warranties
Promotional efforts	After-sales service

SUMMARY

- Given the importance of market and demand analysis, it should be carried out in an orderly and systematic manner. The key steps in such analysis are (i) situational analysis and specification of objectives, (ii) collection of secondary information, (iii) conduct of market survey, (iv) characterisation of the market, (v) demand forecasting, and (vi) market planning.
- The project analyst may do an informal situational analysis which in turn may provide the basis for a formal study.
- For purposes of market study, information may be obtained from secondary and/or primary sources.
- Secondary information is information that has been gathered in some other context and is already available. While secondary information is available economically, its reliability, accuracy, and relevance for the purpose under consideration must be carefully examined.

- Secondary information, though useful, often does not provide a comprehensive basis for market and demand analysis. It needs to be supplemented with primary information gathered through a market survey, specific to the project being appraised, that is likely to be a sample survey.
- Typically, a sample survey consists of the following steps: (i) Define the target population. (ii) Select the sampling schemes and sample size. (iii) Develop the questionnaire. (iv) Recruit and train the field investigators. (v) Obtain information as per the questionnaire from the sample of respondents. (vi) Scrutinise the information gathered. (vii) Analyse and interpret the information.
- Based on the information gathered from secondary sources and through the market survey, the market for the product/service may be described in terms of the following: effective demand in the past and present; breakdown of demand; price; methods of distribution and sales promotion; consumers; supply and competition; and government policy.
- After gathering information about various aspects of the market and demand from primary and secondary sources, an attempt may be made to estimate future demand. A wide range of forecasting methods is available to the market analyst. These may be divided into three broad categories, viz., qualitative methods, time series projection methods, and causal methods.
- To enable the product to reach a desired level of market penetration, a suitable marketing plan, covering pricing, distribution, promotion, and service, needs to be developed.

QUESTIONS

1. Describe briefly the general sources of secondary information available in India.
2. List the important industry-specific sources of secondary information in India.
3. How would you evaluate secondary information?
4. Discuss the key steps in a sample survey.
5. Briefly describe the methods available for demand forecasting.
6. Describe the aspects covered in market planning.

APPENDIX 4A

METHODS OF DEMAND FORECASTING

As indicated in Chapter 4, the various methods of demand forecasting may be classified into three broad categories as follows:

Qualitative Methods

- Jury of executive opinion method
- Delphi method

Time Series Projection Methods

- Trend projection method
- Exponential smoothing method
- Moving averages method

Causal Methods

- Chain ratio method
- Consumption level method
- End use method
- Leading indicator method
- Econometric method

This appendix discusses these methods in some detail. In addition, it looks at the uncertainties in demand forecasting and what may be done to cope with the same.

JURY OF EXECUTIVE OPINION METHOD

This method, which is very popular in practice, involves soliciting the opinions of a group of managers on expected future sales and combining them into a sales estimate.

The advantages of this method are: (i) It is an expeditious method for developing a demand forecast. (ii) It permits consideration of a variety of factors like economic climate, competitive environment, consumer preferences, technological developments, and so on, to be included in the subjective estimates provided by the experts. (iii) It has immense appeal to managers who tend to prefer their judgement to mechanistic forecasting procedures. The disadvantages of this method are: (i) The biases underlying subjective estimates cannot be unearthed easily. (ii) The reliability of this technique is questionable.

DELPHI METHOD

This method is used for eliciting the opinions of a group of experts with the help of a mail survey. The steps involved in this method are:

1. A group of experts is sent a questionnaire by mail and asked to express their views.
2. The responses received from the experts are summarised without disclosing the identity of the experts, and sent back to the experts, along with a questionnaire meant to probe further the reasons for extreme views expressed in the first round.
3. The process may be continued for one or more rounds till a reasonable agreement emerges in the views of the experts.

Delphi method appeals to many organisations for the following reasons: (i) It is intelligible to users. (ii) It has a fancy name. (iii) It seems to be more accurate and less expensive than the traditional face-to-face group meetings.

While the Delphi method is appealing, there are certain question marks: What is the value of expert opinion? What is the contribution of additional rounds and feedback to accuracy?

TREND PROJECTION METHOD

The trend projection method involves (a) determining the trend of consumption by analysing past consumption statistics and (b) projecting future consumption by extrapolating the trend.

Various Trend Relationships

The trend of consumption may be represented by one of the following relationships:

Linear Relationship: $Y_t = a + b\,t$ (4A.1)

Exponential Relationship: $Y_t = a\,e^{b\,t}$ (4A.2)

On logarithmic transformation this becomes:

$$\log\ Y_t = \log\ a + b\,t \qquad (4A.2a)$$

Polynomial Relationship: $Y_t = a_0 + a_1\,t + a_2\,t^2 + \ldots + a_n\,t^n$ (4A.3)

A polynomial of the second degree is:

$$Y_t = a_0 + a_1\,t + a_2\,t^2 \qquad (4A.3a)$$

Cobb Douglas Relationship: $Y_t = a\,t^b$ (4A.4)

On logarithmic transformation this becomes:

$$\log\ Y_t = \log\ a + b\ \log\ t \qquad (4A.4a)$$

In the above equations Y_t represents demand for year t, t is the time variable, and a, b and at's are constants.

Estimation of the Linear Trend

When the trend projection method is used, the most commonly employed relationship is the linear relationship.

$$Y_t = a + b\,t \qquad (4A.1)$$

where Y_t = demand for year t
t = time variable

a = intercept of the relationship
b = slope of the relationship.

To estimate the parameters a and b of the linear relationship, the following methods may be employed: (i) visual curve fitting method, (ii) mid-point method, and (iii) least squares method. To illustrate the use of these methods, the following demand data for a product will be used as shown in Exhibit 4A.1.

EXHIBIT 4A.1

Demand Data

Year	Demand	Year	Demand
1980	10*	1987	20
1981	13	1988	22
1982	14	1989	23
1983	17	1990	22
1984	18	1991	24
1985	18	1992	24
1986	19	1993	25

* in thousand units

For purposes of linear trend analysis, it is convenient to change the time axis as shown in Exhibit 4A.2.

EXHIBIT 4A.2

Change in Time Axis

Actual year	Year for analysis	Actual year	Year for analysis
1980	0	1987	7
1981	1	1988	8
1982	2	1989	9
1983	3	1990	10
1984	4	1991	11
1985	5	1992	12
1986	6	1993	13

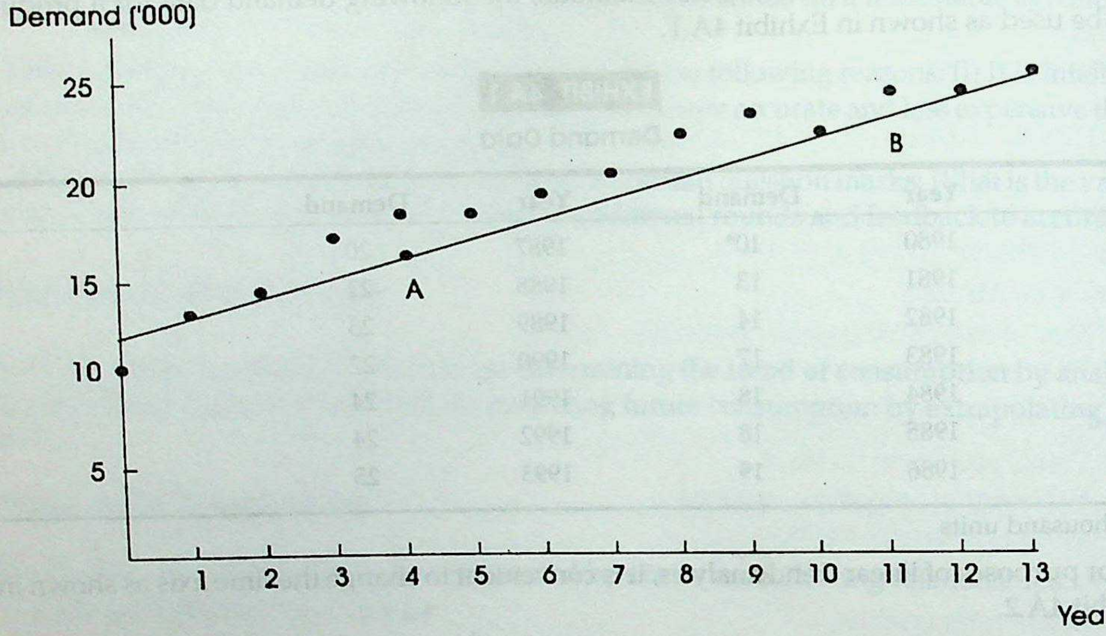
Visual Curve Fitting Method

In the visual curve fitting method a straight line is drawn through the scatter of points plotted on a graph paper. The straight line is drawn in such a way that it seems to 'fit' reasonably well, the relationship being examined. Exhibit 4A.3 shows the scatter of points for demand against time and a straight line which seems to 'fit' reasonably well, the relationship between time and demand.

Once a straight line is fitted visually, the intercept can be easily read by looking at the point where the fitted straight line meets the vertical axis. In our example, the intercept a is at 13,000.

EXHIBIT 4A.3

Visual Curve Fitting



To estimate the slope of the line b we choose any two points on the straight line and apply the following formula.

$$b = \frac{\text{Change in demand coordinate between the two points}}{\text{Change in time coordinate between the two points}}$$

To illustrate, consider the points A and B. The demand and time coordinates of point A are 17 and 4 respectively; the demand and time coordinates of point B are 25 and 12 respectively. The slope of the straight line is:

$$b = \frac{25 - 17}{12 - 4} = 1.0$$

Thus the fitted equation for the straight line is:

$$D_t = 13 + 1\,t \qquad (4A.5)$$

The strengths of the visual curve fitting method are: (i) It uses all the demand observations. (ii) It is fairly easy to understand and apply. Its principal weakness is that it lacks objectivity. Each person may fit a different line and differences may not be easily resolved.

Mid-point Method

According to this method, two observations representing the mid-points of the two halves of the demand time series are connected to get the straight line. In our example, the demand time series has 14 observations which have been divided into two halves as follows:

First half		**Second half**	
Year of Analysis	*Demand*	*Year of Analysis*	*Demand*
0	10	7	20
1	13	8	22
2	14	9	23
3	17	10	22
4	18	11	24
5	18	12	24
6	19	13	25

The mid-points of the two halves are (3,17) and (10, 22). The straight line connecting these two points is the trend line as per the mid-point method. The slope of this line is:

$$b = \frac{22 \text{ (Demand corresponding to the mid-point of the second half)} - 17 \text{ (Demand corresponding to the mid-point of the first half)}}{10 \text{ (Time corresponding to the mid-point of the second half)} - 3 \text{ (Time corresponding to the mid-point of the first half)}}$$

$$= 5/7$$

The intercept a is obtained by solving the linear equation for any one of the mid-points. To illustrate, let us consider the first mid-point for which the demand and time coordinates are 17 and 3. Plugging in these values in the linear relation we get:

$$17 = a + 3b$$

Since b is $\frac{5}{7}$,

We get $17 = a + 3\left(\frac{5}{7}\right)$

So $a = 14.9$

Thus the linear trend relation for demand is:

$$D_t = 14.9 + \frac{5}{7}t$$

$$= 14.9 + 0.70\,t$$

In our example, the number of observations was even (14) so that it could be divided by two. Further, each half had odd (7) number of observations and had a well-defined mid-point. When the number of observations is odd or when it is even but each half of it also has an even number of observations, we have to drop some observations so that we are left with an even number of observations, such that its one-half is an odd number.[1]

---

[1] Here is how we may do it:
1. When the number of observations is $3 + 4n$, drop the middle observation and divide the remaining observations into two equal halves. 2. When the number of observations is $4 + 4n$, drop the first and the last observations and divide the remaining observations into two equal halves. 3. When the number of observations is $5 + 4n$, drop the first, middle, and the last observations and divide the remaining observations into equal halves.

The mid-point method is fairly simple to employ and is free from the subjectivity characterising the visual curve fitting method. It, however, suffers from a severe limitation: the trend line obtained is highly sensitive to the values of the mid-points of the two halves. In order to overcome this limitation, the average of each half, rather than the value of just one year, may be plotted above the mid-point of that half.

Least Squares Method

This method provides a more rigorous basis for determining the linear trend line. The linear relationship is chosen in such a manner that the sum of the squared deviations of the observations from the line is minimised. The parameters, *a* and *b*, of the linear relationship are estimated with the help of the following equations:[2]

$$b = \frac{\sum TY - n\,\overline{T}\,\overline{Y}}{\sum T^2 - n\overline{T}^2} \tag{4A.6}$$

$$a = \overline{Y} - b\,\overline{T} \tag{4A.7}$$

The calculation of *a* and *b*, for our example, is shown in Exhibit 4A.4. The least squares line is shown in Exhibit 4A.5.

The advantages of the least squares method are: (i) It uses all the observations. (ii) The straight line is derived by an objective, statistical procedure. (iii) A measure of goodness of fit is available. The limitations of the least squares method are: (i) The method is somewhat more complicated than the methods discussed earlier. (ii) The results of such an analysis are valid only when certain conditions are satisfied.

---

[2] The equations for *a* and *b* are derived as follows. The sum of squared deviations is

$$\sum (Y - a - bT)^2 \tag{1}$$

To minimise this with respect to *a* and *b*, the partial derivatives of this sum with respect to *a* and *b* are set equal to zero. This gives:

$$\frac{\partial}{\partial a}(Y - a - bT)^2 = -2\sum (Y - a - bT) = 0 \tag{2}$$

$$\frac{\partial}{\partial b}\sum (Y - a - bT)^2 = -2\,T\sum (Y - a - bT) = 0 \tag{3}$$

From the above equations we get the following:

$$\sum Y = \sum (a + bT) \tag{4}$$

$$\sum TY = \sum (aT + bT^2) \tag{5}$$

Solving these two equations, referred to as normal equations, we get the values of *a* and *b* given in Eqs. (4A.6) and (4A.7).

EXHIBIT 4A.4

Calculations in the Least Square Method

T	Y	TY	T^2
0	10	0	0
1	13	13	1
2	14	28	4
3	17	51	9
4	18	72	16
5	18	90	25
6	19	114	36
7	20	140	49
8	22	176	64
9	23	207	81
10	22	220	100
11	24	264	121
12	24	288	144
13	25	325	169
$\sum T = 91$	$\sum Y = 269$	$\sum TY = 1998$	$\sum T^2 = 819$

$$\overline{T} = 6.5 \quad \overline{Y} = 19.21$$

$$b = \frac{\sum TY - n\overline{T}\,\overline{Y}}{\sum T^2 - n\overline{T}^2} = \frac{1998 - 1748.5}{819 - 591.5} = 1.097$$

$$a = \overline{Y} - b\overline{T} = 19.21 - 1.097 \times 6.5 = 12.08$$

where T = time
Y = demand
n = number of observations
$\overline{T}$ = mean of T
$\overline{Y}$ = mean of Y
a = intercept
b = slope

EXPONENTIAL SMOOTHING METHOD

In exponential smoothing, forecasts are modified in the light of observed errors. If the forecast value for year t, F_t, is less than the actual value for year t, S_t, the forecast for the year $t + 1$, F_{t+1}, is set higher than F_t. If $F_t > S_t$, F_{t+1} is set lower than F_t. In general

$$F_{t+1} = F_t + \alpha e_t \tag{4A.8}$$

where F_{t+1} = forecast for year $t+1$
α = smoothing parameter (which lies between 0 and 1)
e_t = error in the forecast for year $t = S_t - F_t$

EXHIBIT 4A.5

Least Squares Fitting

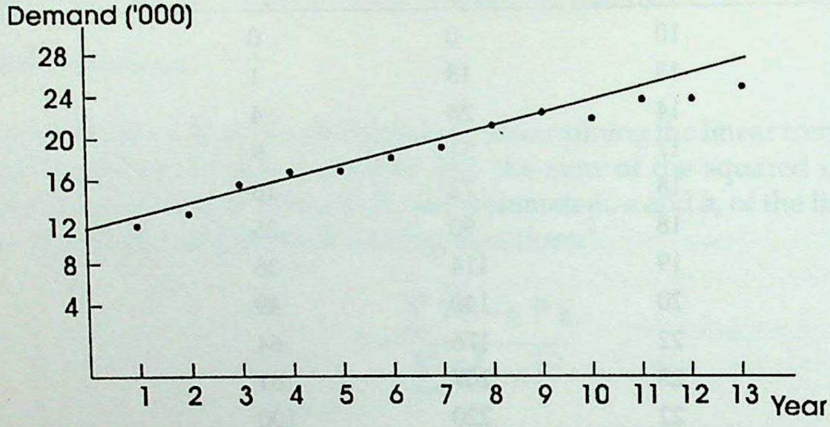


Exhibit 4A.6 shows how the forecasts would be arrived at, given an initial forecast of $F_1 = 29$ and $\alpha = 0.2$ (The choice of these will be discussed later.)

EXHIBIT 4A.6

Derivation of Forecasts

t	Data (S_t)	Forecast (F_t)	Error $(e_t = S_t - F_t)$	Forecast for $t+1$ $F_{t+1} = F_{t+1}\ \alpha\ e_t$
1	28.0	29.0	−1.0	$F_2 = 29.0 + 0.2\ (-1.0) = 28.8$
2	29.0	28.8	0.2	$F_3 = 28.8 + 0.2\ (0.2) = 28.8$
3	28.5	28.8	−0.3	$F_4 = 28.8 + 0.2\ (-0.3) = 28.7$
4	31.0	28.7	2.3	$F_5 = 28.7 + 0.2\ (2.3) = 29.2$
5	34.2	29.2	5.0	$F_6 = 29.2 + 0.2\ (5.0) = 30.2$
6	32.7	30.2	2.5	$F_7 = 30.2 + 0.2\ (2.5) = 30.7$
7	33.5	30.7	2.8	$F_8 = 30.7 + 0.2\ (2.8) = 31.3$
8	31.8	31.3	0.5	$F_9 = 31.3 + 0.2\ (0.5) = 31.4$
9	31.9	31.4	0.5	$F_{10} = 31.4 + 0.2\ (0.5) = 31.5$
10	34.3	31.5	2.8	$F_{11} = 31.5 + 0.2\ (2.8) = 32.1$
11	35.2	32.1	3.1	$F_{12} = 32.1 + 0.2\ (3.1) = 32.7$

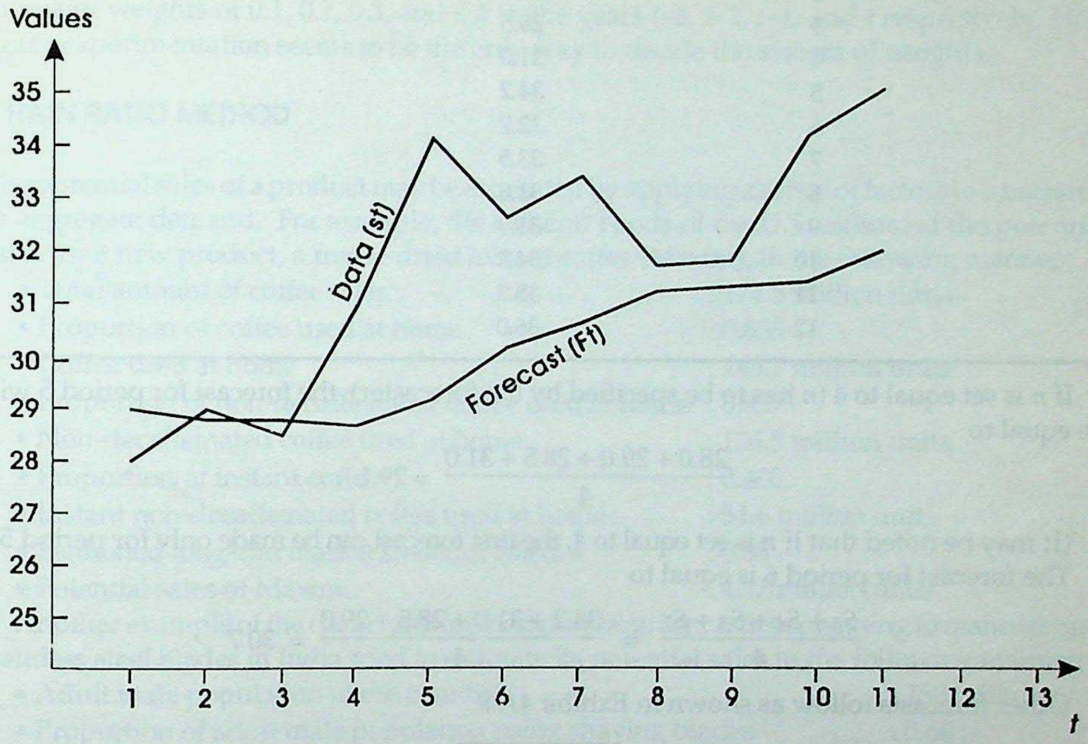
Exhibit 4A.7 shows the plot of the forecasts versus the data. The plot shows that the forecasts have the desirable property of being stable.

How should the first forecast (F_1) and the smoothing parameter (α) be chosen? A simple and reasonably satisfactory rule of thumb is to choose F_1 as the mean of the warm-up sample (The warm-up sample consists of several observations preceding the period for which the forecasting exercise is begun.)

For choosing α, consider several values in the range of 0 to 1 and choose the value which minimises the MSE (mean squared error) in the warm-up period. The mean squared error is defined as

EXHIBIT 4A.7

Forecasts versus Data



$$\frac{1}{n} = \sum (S_i - F_i)^2 \qquad (4A.9)$$

where S_i = actual value of sales in period i

F_i = forecast value of sales in period i

n = number of periods in the "warm-up" sample.

MOVING AVERAGE METHOD

As per the moving average technique of sales forecasting, the forecast for the next period is equal to the average of the sales for several preceding periods.

In symbols,

$$F_{t+1} = \frac{S_t + S_{t-1} + \ldots + S_{t-n+1}}{n} \qquad (4A.10)$$

where F_{t+1} = forecast for the next period

S_t = sales for the current period

n = period over which averaging is done

To illustrate the use of the moving average technique, consider the following time series.

Year	Sales
1	28.0
2	29.0
3	28.5
4	31.0
5	34.2
6	32.7
7	33.5
8	31.8
9	31.9
10	34.3
11	35.2
12	36.0

If n is set equal to 4 (n has to be specified by the forecaster), the forecast for period 5 will be equal to

$$\frac{28.0 + 29.0 + 28.5 + 31.0}{4} = 29.1$$

(It may be noted that if n is set equal to 4, the first forecast can be made only for period 5.) The forecast for period 6 is equal to

$$\frac{S_5 + S_4 + S_3 + S_2}{4} = \frac{34.2 + 31.0 + 28.5 + 29.0}{4} = 30.7$$

Other forecasts follow as shown in Exhibit 4A.8.

EXHIBIT 4A.8

Forecasts

	Data	Forecast	Forecast for $t + 1$
t	S_t	F_t	$F_{t+1} = (S_t + S_{t-1} + S_{t-2} + S_{t-3})/4$
1	28.0		
2	29.0		
3	28.5		
4	31.0		$F_5 = (28.0 + 29.0 + 28.5 + 31.0)/4 = 29.1$
5	34.2	29.1	$F_6 = (29.0 + 28.5 + 31.0 + 34.2)/4 = 30.7$
6	32.7	30.7	$F_7 = (28.5 + 31.0 + 34.2 + 32.7)/4 = 31.6$
7	33.5	31.6	$F_8 = (31.0 + 34.2 + 32.7 + 33.5)/4 = 32.9$
8	31.8	32.9	$F_9 = (34.2 + 32.7 + 33.5 + 31.8)/4 = 33.1$
9	31.9	33.1	$F_{10} = (32.7 + 33.5 + 31.8 + 31.9)/4 = 32.5$
10	34.3	32.5	$F_{11} = (33.5 + 31.8 + 31.9 + 34.3)/4 = 32.9$
11	35.2	32.9	$F_{12} = (31.8 + 31.9 + 34.3 + 35.2)/4 = 33.3$
12	36.0	33.3	

In the above illustration, we set *n* equal to 4. Why should not '*n*' be set equal to 3, 5, 6 or any other number? There seems to be no *apriori* way to determine *n*; it can best be arrived at by experimentation. Another issue may be raised. In Eq. (4A.10), which is based on a simple arithmetic average, all preceding values of sales are weighted equally. Should the more recent data not be accorded higher weightage? For example, it may make more sense to assign weights of 0.1, 0.2, 0.3, and 0.4 to the years t–3, t–2, t–1, and t respectively. Here again experimentation seems to be the only way to decide the system of weights.

CHAIN RATIO METHOD

The potential sales of a product may be estimated by applying a series of factors to a measure of aggregate demand. For example, the General Foods of the U.S. estimated the potential sales for a new product, a freeze-dried instant coffee (Maxim), in the following manner:

- Total amount of coffee sales : 174.5 million units
- Proportion of coffee used at home : 0.835
- Coffee used at home : 145.7 million units
- Proportion of non-decaffeinated coffee used at home : 0.937
- Non-decaffeinated coffee used at home : 136.5 million units
- Proportion of instant coffee : 0.400
- Instant non-decaffeinated coffee used at home : 54.6 million units
- Estimated long-run market share for Maxim : 0.08
- Potential sales of Maxim : 4.37 million units

Another example of the chain ratio method may be given. A firm planning to manufacture stainless steel blades in India tried to estimate its potential sales in the following manner:

- Adult male population in the country : 150 million
- Proportion of adult male population using shaving blades : 0.60
- Adult male population using shaving blades : 90 million
- Number of times in a year a person, who uses shaving blades, shaves : 100
- Total shavings done per year : 9,000 million
- Proportion of shavings done with stainless steel blades : 0.40
- Average number of shavings per stainless steel blade : 6
- Number of stainless steel blades used per year : 600 million
  (9000 million × 0.40)/6
- Proportion of the stainless steel blade market the firm could capture : 0.20
- Potential sales : 120 million

The chain ratio method uses a simple analytical approach to demand estimation. However, its reliability is critically dependent on the ratios and rates of usage used in the process of determining the sales potential. While some of these ratios and rates of usage may be based on objective proportions, others will have to be subjectively defined.

CONSUMPTION LEVEL METHOD

Useful for a product which is directly consumed, this method estimates consumption level on the basis of elasticity coefficients, the important ones being the income elasticity of demand and the price elasticity of demand.

Income Elasticity of Demand

The income elasticity of demand reflects the responsiveness of demand to variations in income. It is measured as follows:

$$E_I = \frac{Q_2 - Q_1}{I_2 - I_1} \times \frac{I_1 + I_2}{Q_2 + Q_1} \tag{4A.11}$$

where E_I = income elasticity of demand
Q_1 = quantity demanded in the base year
Q_2 = quantity demanded in the following year
I_1 = income level in the base year
I_2 = income level in the following year.

Example The following information is available on quantity demanded and income level: $Q_1 = 50$, $Q_2 = 55$, $I_1 = 1{,}000$, and $I_2 = 1{,}02\ 0$. What is the income elasticity of demand? The income elasticity of demand is:

$$E_I = \frac{55 - 50}{1{,}020 - 1{,}000} \times \frac{1{,}000 + 1{,}020}{55 + 50} = 4.81$$

The information on income elasticity of demand along with projected income may be used to obtain a demand forecast. To illustrate, suppose the present per capita annual demand for paper is 1 kg and the present per capita annual income is Rs 7,200. The income elasticity of demand for paper is 2. The projected per capita annual income three years hence is expected to be 10 per cent higher (in real terms) than what it is now. The projected per capita demand for paper three years hence will be:

$$\begin{bmatrix}\text{Present per}\\ \text{capita}\\ \text{demand}\end{bmatrix}\begin{bmatrix}1 + \begin{array}{c}\text{Per capita}\\ \text{change in}\\ \text{income level}\end{array} \times \begin{array}{c}\text{Income}\\ \text{elasticity}\\ \text{of demand}\end{array}\end{bmatrix}$$

$$= (1)\,(1 + 0.10 \times 2) = 1.2 \text{ kg.}$$

The aggregate demand projection for paper will simply be:

Projected per capita demand × Projected population

The income elasticity of demand differs from one product to another. Further, for a given product, it tends to vary from one income group to another and from one region to another. Hence, wherever possible, disaggregative analysis should be attempted.

Price Elasticity of Demand

The price elasticity of demand measures the responsiveness of demand to variations in price. It is defined as:

$$E_p = \frac{Q_2 - Q_1}{P_2 - P_1} \times \frac{P_1 + P_2}{Q_2 + Q_1} \tag{4A.12}$$

where E_p = price elasticity of demand
Q_1 = quantity demanded in the base year
Q_2 = quantity demanded in the following year

P_1 = price per unit in the base year
P_2 = price per unit in the following year

Example The following information is available about a certain product: P_1 = Rs 600, Q_1 = 10,000, P_2 = Rs 800, Q_2 = 9,000. What is the price elasticity of demand? The price elasticity of demand is:

$$E_p = \frac{9{,}000 - 10{,}000}{600 - 800} \times \frac{600 + 800}{9{,}000 + 10{,}000} = -0.37$$

The price elasticity of demand is a useful tool in demand analysis. The future volume of demand may be estimated on the basis of the price elasticity coefficient and expected price change. The price elasticity coefficient may also be used to study the impact of variable prices that may be obtained in future on the economic viability of the project. In using the price elasticity measure, however; the following considerations should be borne in mind: (i) The price elasticity coefficient is applicable to only small variations. (ii) The price elasticity measure is based on the assumption that the structure and behaviour remain constant.

END USE METHOD

Suitable for estimating the demand for intermediate products, the end use method, also referred to as the consumption coefficient method, involves the following steps:

1. Identify the possible uses of the product.
2. Define the consumption coefficient of the product for various uses.
3. Project the output levels for the consuming industries.
4. Derive the demand for the product.

This method may be illustrated with an example. A certain industrial chemical, Indchem, is used by four industries, Alpha, Beta, Gamma, and Kappa. The consumption coefficients for these industries, the projected output levels for these industries for the year *X*, and the projected demand for Indchem are shown in Exhibit 4A.9.

EXHIBIT 4A.9

Projected Demand for Indchem

	Consumption coefficient *	Projected output in year X	Projected demand for Indchem in year X
Alpha	2.0	10,000	20,000
Beta	1.2	15,000	18,000
Kappa	0.8	20,000	16,000
Gamma	0.5	30,000	15,000
		Total	69,000

* This is expressed in tonnes of Indchem required per unit of output of the consuming industry.

As is clear from the foregoing discussion, the key inputs required for the application of the end-use method are: (i) projected output levels of consuming industries (units), and (ii) consumption coefficients. It may be difficult to estimate the projected output levels of consuming industries (units). More important, the consumption coefficients may vary from one period to another in the wake of technological changes and improvements in the methods of manufacturing. Hence, the end-use method should be used judiciously.

LEADING INDICATOR METHOD

Leading indicators are variables which change ahead of other variables, the lagging variables. Hence, observed changes in leading indicators may be used to predict the changes in lagging variables. For example, the change in the level of urbanisation (a leading indicator) may be used to predict the change in the demand for air conditioners (a lagging variable).

Two basic steps are involved in using the leading indicator method: (i) First, identify the appropriate leading indicator(s). (ii) Second, establish the relationship between the leading indicator(s) and the variable to be forecast.

The principal merit of this method is that it does not require a forecast of an explanatory variable. It, however, is characterised by certain problems: (i) It may be difficult to find an appropriate leading indicator(s). (ii) The lead-lag relationship may not remain stable over time. In view of these problems this method has limited use.

ECONOMETRIC METHOD

An econometric model is a mathematical representation of economic relationship(s) derived from economic theory. The primary objective of econometric analysis is to forecast the future behaviour of the economic variables incorporated in the model.

Two types of econometric models are employed: the single equation model and the simultaneous equation model. The single equation model assumes that one variable, the dependent variable (also referred to as the explained variable), is influenced by one or more independent variables (also referred to as the explanatory variables). In other words, one-way causality is postulated. An example of the single equation model is given below:

$$D_t = a_0 + a_1 P_t + a_2 N_t \tag{4A.13}$$

where D_t = demand for a certain product in year t
P_t = price for the product in year t
N_t = income in year t

The simultaneous equation model portrays economic relationships in terms of two or more equations. Consider a highly simplified three-equation econometric model of Indian economy.

$$GNP_t = G_t + I_t + C_t \tag{4A.14}$$

$$I_t = a_0 + a_1 \; GNP_t \tag{4A.15}$$

$$C_t = b_0 + b_1 \; GNP_t \tag{4A.16}$$

where GNP_t = gross national product for year t
G_t = governmental purchases for year t

I_t = gross investment for year t

C_t = consumption for year t

In the above model, Eq. (4A.14) is just a definitional equation which says that the gross national product is equal to the sum of government purchases, gross investment, and consumption. Equation (4A.15) postulates that investment is a linear function of gross national product; Equation (4A.16) posits that consumption is a linear function of gross national product.

The construction and use of an econometric model involves four broad steps.

Specification. This refers to the expression of an economic relationship in a mathematical form. Equation (4A.15), for example, posits that investment is a linear function of gross national product.

Estimation. This involves the determination of the parameter values and other statistics by a suitable method. The principal methods of estimation are the least squares method and the maximum likelihood method, the former being the most popular method in practice.

Verification. This step is concerned with accepting or rejecting the specification as a reasonable approximation to truth on the basis of the results of estimation and appropriate statistical tests applied to them.

Prediction. This involves projection of the value of the explained variable(s).

The econometric method offers certain advantages: (i) The process of econometric analysis sharpens the understanding of complex cause-effect relationships. (ii) The econometric model provides a basis for testing assumptions and for judging how sensitive the results are to changes in assumptions.

The limitations of the econometric method are: (i) It is expensive and data-demanding. (ii) To forecast the behaviour of the dependent variable, one needs the projected values of independent variable(s). The difficulty in obtaining these may be the main limiting factor in employing the econometric method for forecasting purposes.

UNCERTAINTIES IN DEMAND FORECASTING

Demand forecasts are subject to error and uncertainty which arise from three principal sources:

- Data about past and present market
- Methods of forecasting
- Environmental change

Data About Past and Present Market

The analysis of past and present market, which serves as the springboard for the projection exercise, may be vitiated by the following inadequacies of data:

Lack of Standardisation Data pertaining to market features like product, price, quantity, cost, income, etc., may not reflect uniform concepts and measures.

Few Observations Observations available to conduct meaningful analysis may not be enough.

Influence of Abnormal Factors Some of the observations may be influenced by abnormal factors like war or natural calamity.

Methods of Forecasting

Methods used for demand forecasting are characterised by the following limitations.

Inability to Handle Unquantifiable Factors Most of the forecasting methods, quantitative in nature, cannot handle unquantifiable factors which sometimes can be of immense significance.

Unrealistic Assumptions Each forecasting method is based on certain assumptions. For example, the trend projection method is based on the 'mutually compensating effects' premise and the end-use method is based on the constancy of technical coefficients. Uncertainty arises when the assumptions underlying the chosen method tend to be unrealistic and erroneous.

Excessive Data Requirement In general, the more advanced a method, the greater the data requirement. For example, to use an econometric model one has to forecast the future values of explanatory variables in order to project the explained variable. Clearly, predicting the future value of explanatory variables is a difficult and uncertain exercise.

Environmental Changes

The environment in which a business functions is characterised by numerous uncertainties. The important sources of uncertainty are mentioned below:

Technological Change This is a very important but hard-to-predict factor which influences business prospects. A technological advancement may create a new product which performs the same function more efficiently and economically, thereby cutting into the market for the existing product. For example, electronic watches are encroaching on the market for mechanical watches.

Shift in Governmental Policy In India, governmental regulations of business is extensive. Changes in governmental policy, which may be difficult to anticipate, could have a telling effect on business environment: granting of licenses to new companies, particularly foreign companies, may alter the market situation significantly; banning the import of a certain product may create a sheltered market for the existing producers; liberalising the import of some product may lead to stiff competition in the market place; relaxation of price and distribution controls may widen the market considerably.

Developments on the International Scene Developments on the international scene may have a profound effect on industries. The most classic example of recent times is the OPEC price hike in the seventies which led to a near-stagnation in the Indian automobile industry for a few years.

Discovery of New Sources of Raw Material Discovery of new sources of raw materials, particularly hydrocarbons, can have a significant impact on the market situation of several products.

Vagaries of Monsoon Monsoon, which plays an important role in the Indian economy, is somewhat unpredictable. The behaviour of monsoon influences, directly or indirectly, the demand for a wide range of products.

Coping with Uncertainties

Given the uncertainties in demand forecasting, adequate efforts, along the following lines, may be made to cope with uncertainties.

- Conduct analysis with data based on uniform and standard definitions.
- In identifying trends, coefficients, and relationships, ignore the abnormal or out-of-the-ordinary observations.
- Critically evaluate the assumptions of the forecasting methods and choose a method which is appropriate to the situation.
- Adjust the projections derived from quantitative analysis in the light of a due consideration on unquantifiable, but significant, influences.
- Monitor the environment imaginatively to identify important changes.
- Consider likely alternative scenarios and their impact on market and competition.
- Conduct sensitivity analysis to assess the impact on the size of demand for unfavourable and favourable variations of the determining factors from their most likely levels.

QUESTIONS

1. What are the pros and cons of the jury of executive opinion method?
2. Describe and evaluate the Delphi method.
3. Specify the commonly used trend relationships.
4. Discuss the visual curve fitting method and the mid-point method for estimating the linear trend.
5. How is the linear trend calculated with the help of the least squares method?
6. Describe the exponential smoothing method.
7. Illustrate the moving average method with an example.
8. Describe and evaluate the chain ratio method.
9. What is the income elasticity of demand? What is price elasticity?
10. Explain the end use method.
11. Describe the leading indicator method.
12. What is the difference between a single equation model and a simultaneous equation model?
13. Describe the broad steps in the construction and use of an econometric model.
14. Discuss the uncertainties in demand forecasting. How can one cope with them?

PROBLEMS

1. The sales of a certain product during a fourteen-year period have been as follows:

Period	Sales	Period	Sales
1	2,000	8	4,000
2	2,200	9	3,900
3	2,100	10	4,000
4	2,300	11	4,200
5	2,500	12	4,300
6	3,200	13	4,900
7	3,600	14	5,300

Determine the trend line using the mid-point.

2. Find the least squares regression line for the data given in Problem 1.
3. For the data given in Problem 1 assume that the forecast for period 1 was 2,100. If α is equal to 0.3, derive the forecasts for the periods 2 to 14 using the exponential smoothing method.
4. For the data given in Problem 1, set n equal to 3 and develop forecasts for the periods 4 to 14 using the moving averages method.
5. The following information is available on quantity demanded and income level : $Q_1 = 60$, $Q_2 = 70$, $I_1 = 1000$, and $I_2 = 1200$. What is the income elasticity of demand?
6. The following information is available on price and quantity for a certain product : P_1 = Rs 40, $Q_1 = 100{,}000$, P_2 = Rs 50, $Q_2 = 95{,}000$. What is the price elasticity of demand?

5

Technical Analysis

Analysis of technical and engineering aspects is done continually when a project is being examined and formulated. Other types of analyses are dependent and closely intertwined with technical analysis. Technical analysis is concerned primarily with:

- Material inputs and utilities
- Manufacturing process/technology
- Product mix
- Plant capacity
- Location and site
- Machineries and equipments
- Structures and civil works
- Project charts and layouts
- Work schedule

This chapter discusses these aspects of a project and emphasises the need to examine alternatives.

MATERIAL INPUTS AND UTILITIES

An important aspect of technical analysis is concerned with defining the materials and utilities required, specifying their properties in some detail, and setting up their supply programme. There is an intimate relationship between the study of materials and utilities and other aspects of project formulation, particularly those concerned with location, technology, and equipments.

Material inputs and utilities may be classified into four broad categories: (i) raw materials, (ii) processed industrial materials and components, (iii) auxiliary materials and factory supplies, and (iv) utilities.

Raw Materials

Raw materials (processed and/or semi-processed) may be classified into four types: (i) agricultural products, (ii) mineral products, (iii) livestock and forest products, and (iv) marine products.

Agricultural Products In studying agricultural products the quality must first be examined. Then, an assessment of quantities available, currently and potentially, is required. The questions that may be raised in this context are: What is the present marketable surplus? What is the present area under cultivation? What is the yield per acre? What is the likely increase in the area of cultivation? What is the likely increase in yield per acre?

Mineral Products In assessing mineral raw materials, information is required on the quantum of exploitable deposits and the properties of raw materials. The study should provide details of the location, size, and depth of deposits and the viability of opencast or underground mining. In addition, information should be generated on the composition of the ore, level of impurities, need for beneficiation, and physical, chemical and other properties.

Livestock and Forest Products Secondary sources of data on livestock and forest products often do not provide a dependable basis for estimation. Hence, in general, a specific survey may be required to obtain more reliable data on the quantum of livestock produce and forest products.

Marine Products Assessing the potential availability of marine products and the cost of collection is somewhat difficult. Preliminary marine operations, essential for this purpose, have to be provided for in the feasibility study.

Processed Industrial Materials and Components

Processed industrial materials and components (base metals, semi-processed materials, manufactured parts, components, and sub-assemblies) represent important inputs for a number of industries. In studying them the following questions need to be answered: In the case of industrial materials, what are their properties[1]? What is the total requirement of the project? What quantity would be available from domestic sources? What quantity can be procured from foreign sources? How dependable are the supplies? What has been the past trend in prices? What is the likely future behaviour of prices?

Auxiliary Materials and Factory Supplies

In addition to the basic raw materials and processed industrial materials and components, a manufacturing project requires various auxiliary materials and factory supplies like chemicals, additives, packaging materials, paints, varnishes, oils, grease, cleaning materials, etc. The requirements of such auxiliary materials and supplies should be taken into account in the feasibility study.

Utilities

A broad assessment of utilities (power, water, steam, fuel, etc.) may be made at the time of input study though a detailed assessment can be made only after formulating the project with respect to location, technology, and plant capacity. Since the successful operation of a project critically depends on adequate availability of utilities the following questions should be raised while conducting the input study. What quantities are required? What are the sources of supply? What would be the potential availability? What are the likely shortages/bottlenecks? What measures may be taken to augment supplies?

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[1] The analysis here may have to cover the following properties: a. Physical properties: dimensions, form, specific gravity, viscosity, porosity, state (gas, liquid, solid), and melting and boiling points. b. Mechanical properties: formability, machinability, tensile strength, compressive strength, shearing strength, elasticity, fatigue resistance, hardness, and anneal. c. Chemical properties: form (suspension, emulsion), composition, purity, inflammability, and oxidising and reducing potentials. d. Electrical and magnetic properties: magnetisation, conductance, and resistance.

MANUFACTURING PROCESS /TECHNOLOGY

For manufacturing a product/service often two or more alternative technologies are available. For example:

- Steel can be made either by the Bessemer process or the open hearth process.
- Cement can be made either by the dry process or the wet process.
- Soda can be made by the electrolysis method or the chemical method.
- Paper, using bagasse as the raw material, can be manufactured by the kraft process or the soda process or the simon cusi process.
- Vinyl chloride can be manufactured by using one of the following reactions: acetylene on hydrochloric acid or ethylene on chlorine.

Choice of Technology

The choice of technology is influenced by a variety of considerations:

- Plant capacity
- Principal inputs
- Investment outlay and production cost
- Use by other units
- Product mix
- Latest developments
- Ease of absorption

Plant Capacity Often, there is a close relationship between plant capacity and production technology. To meet a given capacity requirement perhaps only a certain production technology may be viable.

Principal Inputs The choice of technology depends on the principal inputs available for the project. In some cases, the raw materials available influence the technology chosen. For example, the quality of limestones determines whether the wet or dry process should be used for a cement plant. Here it may be emphasised that a technology based on indigenous inputs may be preferable to one based on imported inputs because of uncertainties characterising imports, particularly in a country like India.

Investment Outlay and Production Cost The effect of alternative technologies on investment outlay and production cost over a period of time should be carefully assessed.

Use by Other Units The technology adopted must be proven by successful use by other units, preferably in India.

Product Mix The technology chosen must be judged in terms of the total product-mix generated by it, including saleable by-products.

Latest Developments The technology adopted must be based on latest developments in order to ensure that the likelihood of technological obsolescence in the near future, at least, is minimised.

Ease of Absorption The ease with which a particular technology can be absorbed can influence the choice of technology. Sometimes a high-level technology may be beyond the absorptive capacity of a developing country which may lack trained personnel to handle that technology.

Acquiring Technology

The acquisition of technology from some other enterprise may be by way of (i) technology licensing, (ii) outright purchase, or (iii) joint venture arrangement.

Technology Licensing A popular method of acquiring technology, the technology license gives the licensee the right to use patented technology and get related know-how on a mutually agreed basis. Often suppliers of technology tend to provide a technology package which may consist of some elements which are not essential. Hence the technology package should be disaggregated into its component parts like the technology proper, engineering services, supply of intermediate products, supply of equipment by the licensor, use of a trade name, etc. Efforts should be made to acquire only the essential components of the technology package offered by the licensor.

The contract for technology licensing should be carefully scrutinised with respect to: (i) definition of technology to be acquired, (ii) cost of technology licensing, (iii) guarantees provided by the licensor, (iv) duration of technology licensing, and (v) purchase of intermediate products, components, and other inputs.

Purchase of Technology This mode of acquiring technology may be used in certain kinds of industries. It is appropriate when (i) there is no possibility of significant improvement in technology in the foreseeable future, and (ii) there is hardly any need for technological support from the seller of technology.

Joint Venture Arrangement The supplier of technology may participate technically as well as financially in the project. Financial participation is typically in the form of equity holding. It is argued that financial participation may strengthen the motivation of technology supplier to transfer improvements promptly.

Appropriateness of Technology

Appropriate technology refers to those methods of production which are suitable to local economic, social, and cultural conditions. In recent years the debate about appropriate technology has been sparked off mainly by Schumacher and others. The advocates of appropriate technology urge that the technology should be evaluated in terms of the following questions:

- Whether the technology utilises local raw materials?
- Whether the technology utilises local manpower?
- Whether the goods and services produced cater to the basic needs?
- Whether the technology protects ecological balance?
- Whether the technology is harmonious with social and cultural conditions?

PRODUCT MIX

The choice of product mix is guided by market requirements. In the production of most of the items, variations in size and quality are aimed at satisfying a broad range of customers. For example, a garment manufacturer may have a wide range in terms of size and quality to cater to different customers. It may be noted that variation in quality can enable a company to expand its market and enjoy higher profitability. For example, a toilet soap manufacturing unit may by variation in raw material, packaging, and sales promotion offer a high profit margin soap to consumers in upper-income brackets.

While planning the production facilities of the firm, some flexibility with respect to the product mix must be sought. Such flexibility enables the firm to alter its product mix in response to changing market conditions and enhances the power of the firm to survive and grow under different situations. The degree of flexibility chosen may be based on a careful analysis of the additional investment requirement for different degrees of flexibility.

PLANT CAPACITY

Plant capacity[2] (also referred to as production capacity) refers to the volume or number of units that can be manufactured during a given period. Several factors have a bearing on the capacity decision.

- Technological requirement
- Input constraints
- Investment cost
- Market conditions
- Resources of the firm
- Governmental policy

Technological Requirement

For many industrial projects, particularly in process type industries, there is a certain minimum economic size determined by the technological factor. For example, a cement plant should have a capacity of at least 300 tonnes per day in order to use the rotary kiln method; otherwise, it has to employ the vertical shaft method which is suitable for lower capacity.

Input Constraints

In a developing country like India, there may be constraints on the availability of certain inputs. Power supply may be limited; basic raw materials may be scarce; foreign exchange available for imports may be inadequate. Constraints of these kinds should be borne in mind while choosing the plant capacity.

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[2] Plant capacity may be defined in two ways: feasible normal capacity and nominal maximum capacity. The feasible normal capacity refers to the capacity attainable under normal working conditions. This may be established on the basis of the installed capacity, technical conditions of the plant, normal stoppages, downtime for maintenance and tool changes, holidays, and shift patterns. The nominal maximum capacity is the capacity which is technically attainable and this often corresponds to the installed capacity guaranteed by the supplier of the plant. Our discussion will focus on the feasible normal capacity.

Investment Cost

When serious input constraints do not obtain, the relationship between capacity and investment cost is an important consideration. Typically, the investment cost per unit of capacity decreases as the plant capacity increases. This relationship may be expressed as follows:

$$C_1 = C_2\left(\frac{Q_1}{Q_2}\right)^{\alpha} \tag{5.1}$$

where C_1 = derived cost for Q_1 units of capacity
C_2 = known cost for Q_2 units of capacity
α = a factor reflecting capacity-cost relationship.
This is usually between 0.2 and 0.9.

Example Suppose the known investment cost for 5,000 units of capacity for the manufacture of a certain item is Rs 10,00,000. What will be the investment cost for 10,000 units of capacity if the capacity-cost factor is 0.6.

The derived investment cost for 10,000 units of capacity may be obtained as follows:

$$C_1 = 10{,}00{,}000 \times \left(\frac{10{,}000}{5{,}000}\right)^{0.6} = \text{Rs } 15{,}16{,}000$$

Market Conditions

The anticipated market for the product/service has an important bearing on plant capacity. If the market for the product is likely to be very strong, a plant of higher capacity is preferable. If the market is likely to be uncertain, it might be advantageous to start with a smaller capacity. If the market, starting from a small base, is expected to grow rapidly, the initial capacity may be higher than the initial level of demand—further additions to capacity may be effected with the growth of market.

Resources of the Firm

The resources, both managerial and financial, available to a firm define a limit on its capacity decision. Obviously, a firm cannot choose a scale of operations beyond its financial resources and managerial capability.

Government Policy

The capacity level may be influenced by the policy of the government. Traditionally, the policy of the government was to distribute the additional capacity to be created in a certain industry among several firms, regardless of economies of scale. This policy has been substantially modified in recent years and the concept of 'minimum economic capacity' has been adopted in several industries.

LOCATION AND SITE

The choice of location and site follows an assessment of demand, size, and input requirement. Though often used synonymously, the terms 'location' and 'site' should be distinguished. Location refers to a fairly broad area like a city, an industrial zone, or a coastal area; site refers to a specific piece of land where the project would be set up.

The choice of location is influenced by a variety of considerations: proximity to raw materials and markets, availability of infrastructure, governmental policies, and other factors.

Proximity to Raw Materials and Markets

An important consideration for location is the proximity to sources of raw materials and nearness to the market for final products. In terms of a basic locational model, the optimal location is one where the total cost (raw material transportation cost plus production cost plus distribution cost for the final product) is minimised. This generally implies that: (i) a resource-based project like a cement plant or a steel mill should be located close to the source of basic material (for example, limestone in the case of a cement plant and iron-ore in the case of a steel plant); (ii) a project based on imported material may be located near a port; and (iii) a project manufacturing a perishable product should be close to the centre of consumption.

However, for many industrial products proximity to the source of raw material or the centre of consumption may not be very important. Petro-chemical units or refineries, for example, may be located close to the source of raw material, or close to the centre of consumption, or at some intermediate point.

Availability of Infrastructure

Availability of power, transportation, water, and communications should be carefully assessed before a location decision is made.

Adequate supply of power is a very important condition for location—insufficient power can be a major constraint, particularly in the case of an electricity-intensive project like an aluminium plant. In evaluating power supply the following should be looked into: the quantum of power available, the stability of power supply, the structure of power tariff, and the investment required by the project for a tie-up in the network of the power supplying agency.

For transporting the inputs of the project and distributing the outputs of the project, adequate transport connections—whether by rail, road, sea, inland water, or air—are required. The availability, reliability, and cost of transportation for various alternative locations should be assessed.

Given the plant capacity and the type of technology, the water requirement for the project can be assessed. Once the required quantity is estimated, the amount to be drawn from the public utility system and the amount to be provided by the project from surface or sub-surface sources may be determined. For doing this the following factors may be examined: relative costs, relative dependabilities, and relative qualities.

In addition to power, transport, and water, the project should have adequate communication facilities like telephone and telex.

Governmental Policies

Government policies have a bearing on location. In the case of public sector projects, location is directly decided by the government. It may be based on a wider policy for regional dispersion of industries.

In the case of private sector projects, location is influenced by certain governmental restrictions and inducements. The government may prohibit the setting up of industrial projects in certain areas which suffer from urban congestion. More positively, the government offers inducements for establishing industries in backward areas. These inducements consist of subsidies, concessional finance, tax reliefs, and other benefits.

Other Factors

Several other factors have to be assessed before reaching a location decision: ease in coping with environmental pollution, labour situation, climatic conditions, and general living conditions.

A project may cause environmental pollution in various ways: it may throw gaseous emissions; it may produce liquid and solid discharges; it may cause noise, heat, and vibrations. The location study should analyse the costs of mitigating environmental pollution to tolerable levels at alternative locations.

The labour situation at alternative locations may be assessed in terms of: (i) the availability of labour, skilled, semi-skilled, and unskilled; (ii)the past trends in labour rates, the prevailing labour rates, and the projected labour rates; and (iii) the state of industrial relations judged in terms of the frequency and severity of strikes and lockouts and the attitudes of labour and management.

The climatic conditions (like temperature, humidity, wind, sunshine, rainfall, snowfall, dust, flooding, and earthquakes) have an important influence on location. They have a bearing on cost as they determine the extent of air-conditioning, de-humidification, refrigeration, special drainage, etc., required for the project.

General living conditions, judged in terms of cost of living, housing situation, and facilities for education, recreation, transport, and medical care, need to be assessed at alternative locations.

Site Selection

Once the broad location is chosen, attention needs to be focussed on the selection of a specific site. Two to three alternative sites must be considered and evaluated with respect to cost of land and cost of site preparation and development.

The cost of land tends to differ from one site to another in the same broad location. Sites close to a city cost more whereas sites away from the city cost less. Sites in an industrial area developed by a governmental agency may be available at a concessional rate.

The cost of site preparation and development depends on the physical features of the site, the need to demolish and relocate existing structures, and the work involved in obtaining utility connections to the site. The last element, viz., the work involved in obtaining utility connections and the cost associated with it should be carefully looked into. It may be noted in this context that the cost of the following may vary significantly from site to site: power transmission lines from the main grid, railway siding from the nearest railroad, feeder road connecting with the main road, transport of water, and disposal of effluents.

MACHINERIES AND EQUIPMENTS

The requirement of machineries and equipments is dependent on production technology and plant capacity. It is also influenced by the type of project. For a process-oriented industry, like a petrochemical unit, machineries and equipments required should be such that the various stages are matched well. The choice of machineries and equipments for a manufacturing industry is somewhat wider as various machines can perform the same function with varying degrees of accuracy. For example, the configuration of machines required for the manufacture of refrigerators could take various forms. To determine the kinds of machinery and equipment required for a manufacturing industry, the following procedure may be followed: (i) Estimate the likely levels of production over time. (ii) Define the various machining and other operations. (iii) Calculate the machine hours required for each type of operation. (iv) Select machineries and equipments required for each function.

The equipments required for the project may be classified into the following types: (i) plant (process) equipments, (ii) mechanical equipments, (iii) electrical equipments, (iv) instruments, (v) controls, (vi) internal transportation system, and (vii) others.

In addition to the machineries and equipments, a list should be prepared of spare parts and tools required. This may be divided into: (i) spare parts and tools to be purchased with the original equipment, and (ii) spare parts and tools required for operational wear and tear.

Constraints in Selecting Machineries and Equipments

In selecting the machineries and equipments certain constraints should be borne in mind: (i) there may be a limited availability of power to set up an electricity-intensive plant like, for example, a large electric furnace; (ii) there may be difficulty in transporting a heavy equipment to a remote location; (iii) workers may not be able to operate, at least in the initial periods, certain sophisticated equipments such as numerically controlled machines; (iv) the import policy of the government may preclude the import of certain machineries and equipments.

Procurement of Plant and Machinery

For procuring plant and machinery, orders for different items of plant and machinery may be placed with different suppliers or a turnkey contract may be given for the entire plant and machinery to a single supplier. The factors to be considered in selecting the supplier/s of plant and machinery are the desired quality of machinery, the level of technological sophistication, the relative reputation of various suppliers, the expected delivery schedules, the preferred payment terms, and the required performance guarantees[3]. If inhouse technical expertise is inadequate, external consultant/s may be employed to select plant and machinery and supervise the installation of the same.

STRUCTURES AND CIVIL WORKS

Structures and civil works may be divided into three categories: (i) site preparation and development, (ii) buildings and structures, and (iii) outdoor works.

---

[3] Performance guarantees provided by machinery suppliers are of three types: mechanical guarantees, input guarantees, and output guarantees.

Site Preparation and Development

This covers the following: (i) grading and leveling of the site, (ii) demolition and removal of existing structures, (iii) relocation of existing pipelines, cables, roads, power lines, etc., (iv) reclamation of swamps and draining and removal of standing water, (v) connections for the following utilities from the site to the public network: electric power (high tension and low tension), water for drinking and other purposes, communications (telephone, telex, etc.), roads, railway sidings, and (vi) other site preparation and development work.

Buildings and Structures

Buildings and structures may be divided into: (i) factory or process buildings; (ii) ancillary building required for stores, warehouses, laboratories, utility supply centres, maintenance services, and others; (iii) administrative buildings; (iv) staff welfare buildings, cafeteria, and medical service buildings; and (v) residential buildings.

Outdoor Works

Outdoor works cover (i) supply and distribution of utilities (water, electric power, communication, steam, and gas); (ii) handling and treatment of emission, wastages, and effluents; (iii) transportation and traffic arrangements (roads, railway tracks, paths, parking areas, sheds, garages, traffic signals, etc.); (iv) outdoor lighting; (v) landscaping; and (vi) enclosure and supervision (boundary wall, fencing, barriers, gates, doors, security posts, etc.)

PROJECT CHARTS AND LAYOUTS

Once data is available on the principal dimensions of the project—market size, plant capacity, production technology, machineries and equipments, buildings and civil works, conditions obtaining at plant site, and supply of inputs to the project—project charts and layouts may be prepared. These define the scope of the project and provide the basis for detailed project engineering and estimation of investment and production costs.

The important charts and layouts drawings are briefly described below.

1. *General Functional Layout* This shows the general relationship between equipments, buildings, and civil works. In preparing this layout, the primary consideration is to facilitate smooth and economical movement of raw materials, work-in-process, and finished goods. This means that:

   (a) The layout should seek to allow traffic flow in one direction to the extent possible, with a minimum of crossing.

   (b) Godowns, workshops, and other services must be functionally situated with respect to the main factory buildings.

2. *Material Flow Diagram* This shows the flow of materials, utilities, intermediate products, final products, by-products, and emissions. Along with the material flow diagram, a quantity flow diagram showing the quantities of flow may be prepared.

3. *Production Line Diagrams* These show how the production would progress along with the key information for main equipments.

4. *Transport Layout* This shows the distances and means of transport outside the production line.

5. *Utility Consumption Layout* This shows the principal consumption points of utilities (power, water, gas, compressed air, etc.) and their required quantities and qualities. These layouts provide the basis for developing specifications for utility supply installations.

6. *Communication Layout* This shows how the various parts of the project will be connected with telephone, telex, intercom, etc.

7. *Organisational Layout* This shows the organisational set-up of the project along with information on personnel required for various departments and their inter-relationship.

8. *Plant Layout* The plant layout is concerned with the physical layout of the factory. In certain industries, particularly process industries, the plant layout is dictated by the production process adopted. In manufacturing industries, however, there is much greater flexibility in defining the plant layout. The important considerations in preparing the plant layout are:

(a) Consistency with production technology
(b) Smooth flow of goods from one stage to another
(c) Proper utilisation of space
(d) Scope of expansion
(e) Minimisation of production cost
(f) Safety of personnel

WORK SCHEDULE

The work schedule, as its name suggests, reflects the plan of work concerning installation as well as initial operation. The purpose of the work schedule is:

- To anticipate problems likely to arise during the installation phase and suggest possible means for coping with them.
- To establish the phasing of investments taking into account the availability of finances.
- To develop a plan of operations covering the initial period (the running-in period).

Often, it is found that the required inputs like raw material and power are not available in adequate quantity when the plant is ready for commissioning, or the plant is not ready when the raw material arrives.

In the first case the plant remains idle and in the second the material may tend to deteriorate and/or pose problems of storage. To avoid losses arising from idle capacity and deterioration of stocks of material, work schedule should be drawn up with care and realism so that the commissioning of plant is reasonably synchronised with the availability of the basic inputs.

NEED FOR CONSIDERING ALTERNATIVES

The need for considering alternatives has been touched upon earlier. This point, however, needs to be emphasised. There are alternative ways of transforming an idea into a concrete project. These alternatives may differ in one or more of the following aspects:

- Nature of project
- Production process
- Product quality
- Scale of operation and time phasing
- Location

Nature of Project The project may envisage the manufacture of all the parts and components in a vertically integrated unit or it may consist of an assembly type unit which obtains the bulk of the parts and components from outside suppliers. The project may consist of processing up to the finished stage or may stop at a semi-finished stage. These alternatives are available with respect to the nature of the project.

Production Process There may be several alternatives with respect to the production process. The availability and characteristics of raw materials, the cost structure, and the nature of markets served are factors that have to be borne in mind while deciding about the process.

Product Quality Barring a few products like clinical thermometers where a certain standard has to be maintained, the choice with respect to quality is fairly wide. This is particularly true in the case of consumer products like textiles, footwear, etc. The quality and product range decisions would depend on the characteristics of the market, the elasticity of demand, consumer preferences, and the nature of competition.

Scale of Operation and Time Phasing In many cases several scales of operation are feasible technically and financially. The choice of a particular scale would depend on the financial resources available, the nature of competition, the nature of demand, and the economies of scale.

Further, a given capacity may be installed in one stage or in phases. The capital cost of capacity installation is usually lower when it is done in one stage. The cost of idle capacity, however, is higher when it is built in a single stage. The trade-off between these costs would determine the optimal pattern of time phasing.

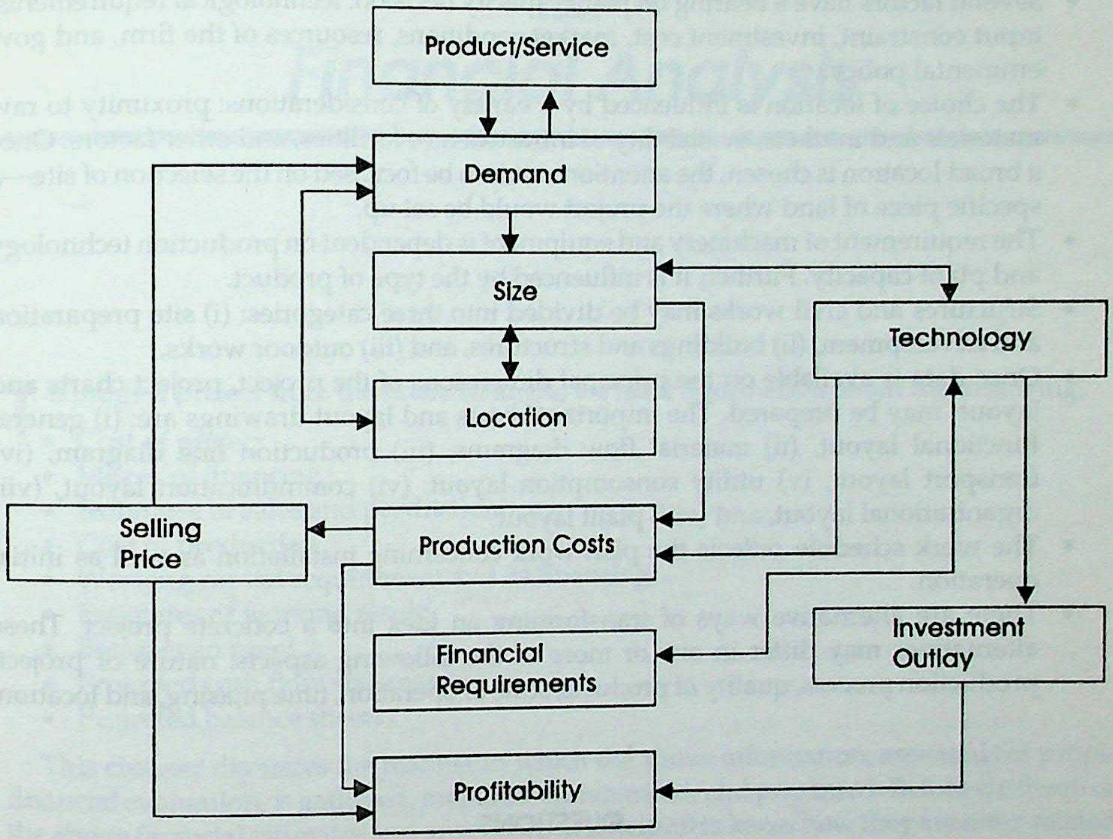
Location Location and size are closely interrelated. Perhaps the same demand could be satisfied by: (i) a single plant for the entire market; or (ii) one large plant for the bulk of the market with a few smaller plants for the remaining market; or (iii) several plants of similar size spread over the market areas. The choice would depend mainly on the trade-off between economies of scale in manufacturing and economies of distribution.

Key Project Inter-linkages

While evaluating various alternatives, the inter-linkages among key facets of the project like product (or service), demand, plant capacity, production technology, location, investment outlay, financial resources, production costs, selling price, and profitability must be borne in mind . Exhibit 5.1 shows these inter-linkages pictorially.

EXHIBIT 5.1

Key Project Inter-linkages


Product/Service
Demand
Size
Technology
Location
Selling Price
Production Costs
Financial Requirements
Investment Outlay
Profitability

SUMMARY

- Technical analysis is concerned primarily with material inputs, production technology, plant capacity, location and site, machineries and equipments, structures and civil works, project charts and layouts, and work schedule.
- An important aspect of technical analysis is concerned with defining the materials and inputs required, specifying their properties in some detail, and setting up their supply programme. Materials may be classified into four broad categories: (i) raw materials, (ii) processed industrial materials and components, (iii) auxiliary materials and factory supplies, and (iv) utilities.
- For manufacturing a product/service often two or more alternative technologies are available. The choice of technology is influenced by a variety of considerations: plant capacity, principal inputs, investment outlay, production cost, use by other units, product mix, latest developments, and ease of absorption.

- The acquisition of technology from some other enterprise may be by way of (i) technology licensing, (ii) outright purchase, or (iii) joint venture arrangement.
- Appropriate technology refers to those methods of production which are suitable to local economic, social, and cultural conditions.
- Several factors have a bearing on plant capacity decision: technological requirements, input constraint, investment cost, market conditions, resources of the firm, and governmental policy.
- The choice of location is influenced by a variety of considerations: proximity to raw materials and markets, availability of infrastructure facilities, and other factors. Once a broad location is chosen, the attention needs to be focussed on the selection of site—a specific piece of land where the project would be set up.
- The requirement of machinery and equipment is dependent on production technology and plant capacity. Further, it is influenced by the type of product.
- Structures and civil works may be divided into three categories: (i) site preparation and development, (ii) buildings and structures, and (iii) outdoor works.
- Once data is available on the principal dimensions of the project, project charts and layout may be prepared. The important charts and layout drawings are: (i) general functional layout, (ii) material flow diagrams, (iii) production line diagram, (iv) transport layout, (v) utility consumption layout, (vi) communication layout, (vii) organisational layout, and (viii) plant layout.
- The work schedule reflects the plan work concerning installation as well as initial operation.
- There are alternative ways of transforming an idea into a concrete project. These alternatives may differ in one or more of the following aspects: nature of project, production process, quality of products, scale of operation, time phasing, and location.

QUESTIONS

1. What aspects are considered in technical analysis?
2. What are the broad types of materials and inputs? What questions would you raise in assessing whether the material and input requirements of the project would be reasonably met?
3. What factors have a bearing on choice of technology?
4. What are the various ways of acquiring technology?
5. How would you evaluate the appropriateness of a technology?
6. What factors have a bearing on the plant capacity?
7. What considerations influence the choice of location?
8. How would you determine the kinds of machinery and equipments required for a manufacturing industry?
9. Describe the important charts and layout drawings.
10. What is a work schedule ? What purpose does it serve?
11. Discuss the importance of considering alternative ways of transforming an idea into a concrete project.

6

Financial Analysis

To judge a project from the financial angle, we need information about the following:

- Cost of project
- Means of financing
- Estimates of sales and production
- Cost of production
- Working capital requirement and its financing
- Estimates of working results
- Break-even point
- Projected cash flow statements
- Projected balance sheets

This chapter discusses the manner in which the above information, essential for proper financial evaluation, is gathered, prepared, summarised, and presented. Before we dwell on the above financial estimates and projections, it is helpful to know how they are inter-related. Exhibit 6.1 presents a schematic diagram showing the inter-relationship.

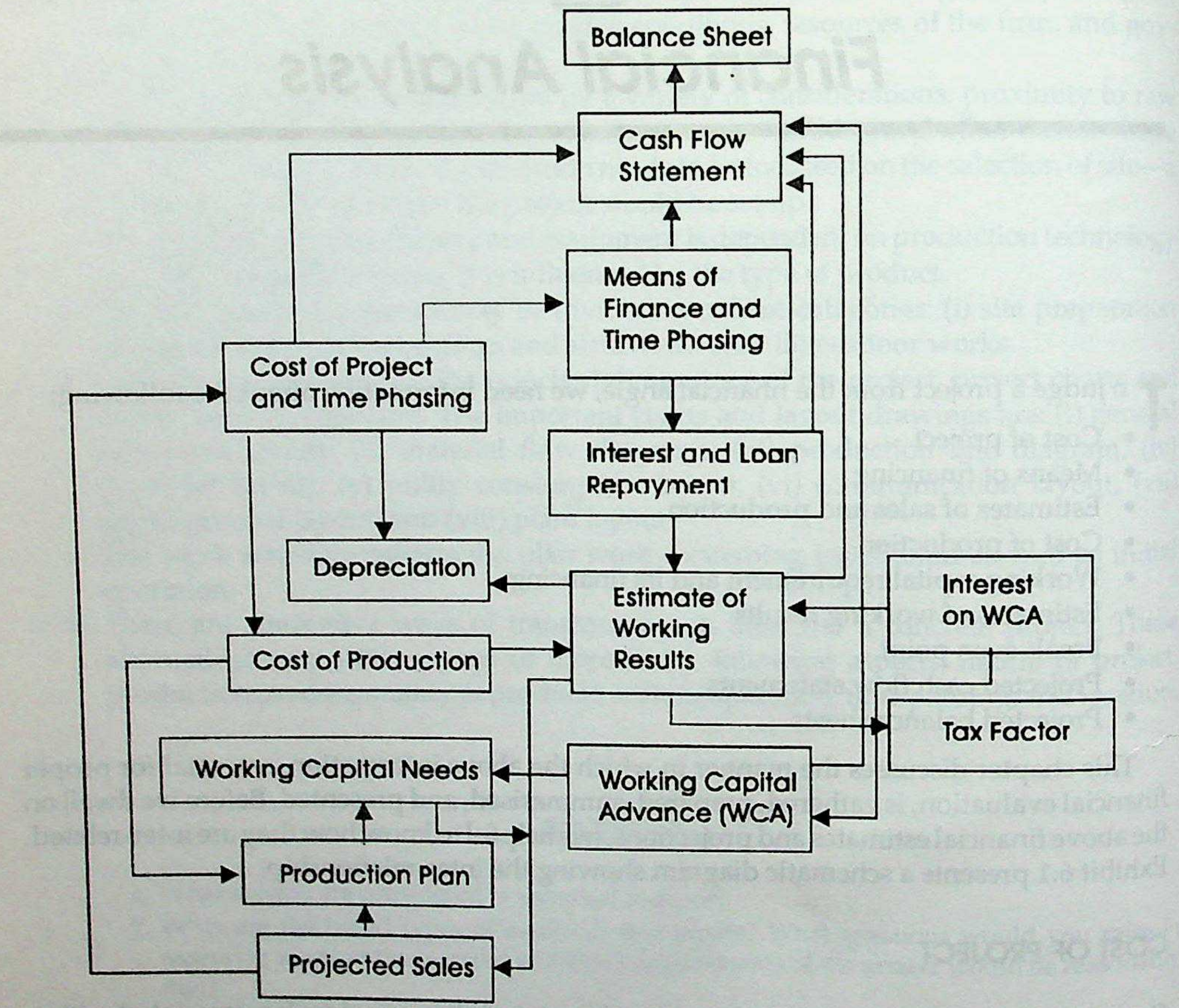
COST OF PROJECT

Conceptually, the cost of project represents the total of all items of outlay associated with a project which are supported by long-term funds. It is the sum of the outlays on the following:

- Land and site development
- Buildings and civil works
- Plant and machinery
- Technical know-how and engineering fees
- Expenses on foreign technicians and training of Indian technicians abroad
- Miscellaneous fixed assets
- Preliminary and capital issue expenses
- Pre-operative expenses
- Provision for contingencies
- Margin money for working capital
- Initial cash losses

EXHIBIT 6.1

Financial Projections


Balance Sheet
Cash Flow Statement
Means of Finance and Time Phasing
Cost of Project and Time Phasing
Interest and Loan Repayment
Depreciation
Estimate of Working Results
Interest on WCA
Cost of Production
Tax Factor
Working Capital Needs
Working Capital Advance (WCA)
Production Plan
Projected Sales

Land and Site Development

The cost of land and site development is the sum of the following:

- Basic cost of land including conveyance and other allied charges
- Premium payable on leasehold and conveyance charges
- Cost of levelling and development
- Cost of laying approach roads and internal roads
- Cost of gates
- Cost of tube wells

The cost of land varies considerably from one location to another. While it is very high in urban and even semi-urban locations, it is relatively low in rural locations. The expenditure on site development, too, varies widely depending on the location and topography of the land.

Buildings and Civil Works

Buildings and civil works cover the following:

- Buildings for the main plant and equipments
- Buildings for auxiliary services like steam supply, workshops, laboratory, water supply, etc.
- Godowns, warehouses, and open yard facilities
- Non-factory buildings like canteen, guest houses, time office, excise house, etc.
- Quarters for essential staff
- Silos, tanks,wells, chests, basins, cisterns, hoopers, bins, and other structures necessary for installation of plant and equipment
- Garages
- Sewers, drainage, etc.
- Other civil engineering works.

The cost of buildings and civil works depends on the kinds of structures required which, in turn, are dictated largely by the requirements of the manufacturing process. Once the kinds of structures required are specified, cost estimates are based on plinth areas and rates for various types of structures. These rates, of course, vary with the location to some extent.

Plant and Machinery

The cost of plant and machinery, typically the most significant component of project cost, consists of the following:

- Cost of imported machinery: This is the sum of (i) FOB (free on board) value, (ii) shipping, freight, and insurance cost, (iii) import duty, and (iv) clearing, loading, unloading, and transportation charges.
- Cost of indigenous machinery: This consists of (i) FOR (free on rail) cost, (ii) sales tax, octroi, and other taxes, if any, and (iii) railway freight and transport charges to site.
- Cost of stores and spares
- Foundation and installation charges

The cost of plant and machinery is based on the latest available quotation adjusted for possible escalation. Generally, the provision for escalation is equal to the following product: (latest rate of annual inflation applicable to the plant and machinery) × (length of the delivery period).

Technical Know-how and Engineering Fees

Often it is necessary to engage technical consultants or collaborators from India and/or abroad for advice and help in various technical matters like preparation of project report, choice of technology, selection of plant and machinery, detailed engineering, and so on. While the amount payable for obtaining technical know-how and engineering services for setting up the project is a component of project cost, the royalty payable annually, which is typically a percentage of sales, is an operating expense taken into account in the preparation of the projected profitability statements.

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Acc. No. 7098 (D)
Dated 17-8-2015

Expenses on Foreign Technicians and Training of Indian Technicians Abroad

Services of foreign technicians may be required in India for setting up the project and supervising the trial runs. Expenses on their travel, boarding, and lodging along with their salaries and allowances must be shown here. Likewise, expenses on Indian technicians who require training abroad must also be included here.

Miscellaneous Fixed Assets

Fixed assets and machinery which are not part of the direct manufacturing process may be referred to as miscellaneous fixed assets. They include items like furniture, office machinery and equipment, tools, vehicles, railway siding, diesel generating sets, transformers, boilers, piping systems, laboratory equipments, workshop equipments, effluent treatment plants, fire fighting equipments, and so on. Expenses incurred for procurement or use of patents, licenses, trade marks, copyrights, etc., and deposits made with the electricity board may also be included here.

Preliminary and Capital Issue Expenses

Expenses incurred for identifying the project, conducting the market survey, preparing the feasibility report, drafting the memorandum and articles of association, and incorporating the company are referred to as preliminary expenses.

Expenses borne in connection with the raising of capital from the public are referred to as capital issue expenses. The major components of capital issue expenses are: underwriting commission, brokerage, fees to managers and registrars, printing and postage expenses, advertising and publicity expenses, listing fees, and stamp duty.

Pre-operative Expenses

Expenses of the following types incurred till the commencement of commercial production are referred to as pre-operative expenses: (i) establishment expenses, (ii) rent, rates, and taxes, (iii) travelling expenses, (iv) interest and commitment charges on borrowings, (v) insurance charges, (vi) mortgage expenses, (vii) interest on deferred payments, (viii) start-up expenses, and (ix) miscellaneous expenses.

Pre-operative expenses are directly related to the project implementation schedule. So, delays in project implementation, which are fairly common, tend to push up these expenses. Appreciative of this, financial institutions allow for some delay (20 to 25 per cent) in the project implementation schedule and accordingly permit a cushion in the estimate for pre-operative expenses.

Pre-operative expenses incurred up to the point of time the plant and machinery are set up may be capitalised by apportioning them to fixed assets on some acceptable basis. Pre-operative expenses incurred from the point of time the plant and machinery are set up are treated as revenue expenditure. The firm may, however, treat them as deferred revenue expenditure and write them off over a period of time.

Provision for Contingencies

A provision for contingencies is made to provide for certain unforeseen expenses and price increases over and above the normal inflation rate which is already incorporated in cost estimates.

To estimate the provision for contingencies the following procedure may be followed: (i) Divide the project cost items into two categories, viz., 'firm' cost items and 'non-firm' cost items (firm cost items are those which have already been acquired or for which definite arrangements have been made). (ii) Set the provision for contingencies at 5 to 10 per cent of the estimated cost of non-firm cost items. Alternatively, make a provision of 10 per cent for all items (including the margin money for working capital) if the implementation period is one year or less. For every additional one year, make an additional provision of 5 per cent.

Margin Money for Working Capital

The principal support for working capital is provided by commercial banks and trade creditors. However, a certain part of working capital requirement has to come from long-term sources of finance. Referred to as the 'margin money for working capital', this is an important element of the project cost.

The margin money for working capital is sometimes utilised for meeting over-runs in capital cost. This leads to a working capital problem (and sometimes a crisis) when the project is commissioned. To mitigate this problem, financial institutions stipulate that a portion of the loan amount, equal to the margin money for working capital, be blocked initially so that it can be released when the project is completed.

Initial Cash Losses

Most of the projects incur cash losses in the initial years. Yet, promoters typically do not disclose the initial cash losses because they want the project to appear attractive to the financial institutions and the investing public. Failure to make provision for such cash losses in the project cost generally affects the liquidity position and impairs the operations. Hence prudence calls for making a provision, overt or covert, for the estimated initial cash losses.

MEANS OF FINANCE

To meet the cost of project the following means of finance are available:

- Share capital
- Term loans
- Debenture capital
- Deferred credit
- Incentive sources
- Miscellaneous sources

Share Capital There are two types of share capital—equity capital and preference capital. *Equity capital* represents the contribution made by the owners of the business, the equity shareholders, who enjoy the rewards and bear the risks of ownership. Equity capital being risk capital carries no fixed rate of dividend. *Preference capital* represents the contribution made by preference shareholders and the dividend paid on it is generally fixed.

Term Loans Provided by financial institutions and commercial banks, *term loans* represent secured borrowings which are a very important source (and often the major source) for financing new projects as well as expansion, modernisation, and renovation schemes of existing firms. There are two broad types of term loans available in India: *rupee term loans* and *foreign currency term loans*. While the former are given for financing land, building, civil works, indigenous plant and machinery, and so on, the latter are provided for meeting the foreign currency expenditures towards import of equipments and technical know-how.

Debenture Capital Akin to promissory notes, debentures are instruments for raising debt capital. There are two broad types of debentures: non-convertible debentures and convertible debentures. *Non-convertible debentures* are straight debt instruments. Typically they carry a fixed rate of interest and have a maturity period of 5 to 9 years. *Convertible debentures*, as the name implies, are debentures which are convertible, wholly or partly, into equity shares. The conversion period and price are announced in advance.

Deferred Credit Many a time the suppliers of plant and machinery offer a deferred credit facility under which payment for the purchase of plant and machinery can be made over a period of time.

Incentive Sources The government and its agencies may provide financial support as incentive to certain types of promoters or for setting up industrial units in certain locations. These incentives may take the form of *seed capital assistance* (provided at a nominal rate of interest to enable the promoter to meet his contribution to the project), or *capital subsidy* (to attract industries to certain locations), or *tax deferment or exemption* (particularly from sales tax) for a certain period.

Miscellaneous Sources A small portion of project finance may come from miscellaneous sources like unsecured loans, public deposits, and leasing and hire purchase finance. *Unsecured loans* are typically provided by the promoters to bridge the gap between the promoters' contribution (as required by the financial institutions) and the equity capital the promoters can subscribe to. *Public deposits* represent unsecured borrowings from the public at large. *Leasing and hire purchase finance* represent a form of borrowing different from the conventional term loans and debenture capital.

Planning the Means of Finance

We described the various means of finance that can be tapped for a project. How should you go about determining the specific means of finance for a given project? The guidelines and considerations that should be borne in mind for this purpose are as follows:

- Norms of regulatory bodies and financial institutions
- Key business considerations

Norms of Regulatory Bodies and Financial Institutions In many countries, including India, the proposed means of financing for a project must be either approved by a regulatory agency or conform to certain norms laid down by the government or financial institutions in this regard. The primary purpose of such regulation is to impart prudence to project financing decisions and provide a measure of protection to investors. In addition, the norms of financial institutions, which often provide substantial assistance to projects significantly shape and circumscribe project financing decisions.

Key Business Considerations The key business considerations which are relevant for the project financing decision are: cost, risk, control, and flexibility.

Cost In general the cost of debt funds is lower than the cost of equity funds. Why? The primary reason is that the interest payable on debt capital is a tax-deductible expense whereas the dividend payable on equity capital is not.

Risk The two main sources of risk for a firm (or project) are: business risk and financial risk. *Business risk* refers to the variability of earnings before interest and taxes and arises mainly from fluctuations in demand and variability of prices and costs. *Financial risk* represents the risk arising from financial leverage. It must be emphasised that while debt capital is cheap it is also risky because of the fixed financial burden associated with it.

Generally the affairs of the firm are, or should be, managed in such a way that the total risk borne by equity shareholders, which consists of business risk and financial risk, is not unduly high. This implies that if the firm is exposed to a high degree of business risk, its financial risk should be kept low. On the other hand, if the firm has a low business risk profile, it can assume a high degree of financial risk.

Control From the point of view of the promoters of the project, the issue of control is important. They would ordinarily prefer a scheme of financing which enables them to maximise their control, current as well as potential, over the affairs of the firm, given their commitment of funds to the project.

Flexibility This refers to the ability of a firm (or project) to raise further capital from any source it wishes to tap to meet the future financing needs. This provides manoeuverability to the firm. In most practical situations, flexibility means that the firm does not exhaust fully its debt capacity. Put differently, it maintains reserve borrowing powers to enable it to raise debt capital to meet largely unforeseen future needs.

ESTIMATES OF SALES AND PRODUCTION

Typically, the starting point for profitability projections is the forecast for sales revenues. In estimating sales revenues, the following considerations should be borne in mind:

1. It is not advisable to assume a high capacity utilisation level in the first year of operation. Even if the technology is simple and the company may not face technical problems in achieving a high rate of capacity utilisation in the first year itself, there are likely to be other constraints like raw material shortage, limited power, marketing problems, etc. It is sensible to assume that capacity utilisation would be somewhat low in the first year and rise thereafter gradually to reach the maximum level in the third or fourth year of operation. A reasonable assumption with respect to capacity utilisation is as follows: 40–50 per cent of the installed capacity in the first year, 50–80 per cent in the second year, and 80–90 per cent from the third year onwards.
2. It is not necessary to make adjustments for stocks of finished goods. For practical purposes, it may be assumed that production would be equal to sales.
3. The selling price considered should be the price realisable by the company net of excise duty. It shall, however, include dealers' commission which is shown as an item of expense (as part of sales expenses).
4. The selling price used may be the present selling price—it is generally assumed that changes in selling price will be matched by proportionate changes in cost of production.[1] If a portion of production is saleable at controlled price, take the controlled price for that portion.

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[1] This assumption is commonly used by financial institutions. However, it is not very convincing.

Sales and production are closely inter-related. Hence they may be estimated together. For this purpose, the format given in Exhibit 6.2, which shows Form XII A of the application form used by all-India financial institutions in India, may be employed.

EXHIBIT 6.2

Estimates of Production and Sales

(Details may be furnished separately for each product and until the plant reaches maximum capacity utilisation)

	Product				Product			
	1st yr.	*2nd yr.*	*3rd yr.*	*4th yr.*	*1st yr.*	*2nd yr.*	*3rd yr.*	*4th yr.*
1. Installed capacity (qty. per day per annum)								
2. No. of working days								
3. No. of shifts								
4. Estimated production per day (qty.)								
5. Estimated annual production (qty.)								
6. Estimated output as % of plant capacity								
7. Sales (qty.) (after adjusting stocks)								
8. Value of sales (in '000 of Rs) Product								
(I)								
(II)								
(III)								

Note: Production in the initial period should be assumed at a reasonable level of utilisation of capacity increasing gradually to attain full capacity in subsequent years.

COST OF PRODUCTION

Given the estimated production, the cost of production may be worked out. The major components of cost of production are:

- Material cost
- Utilities cost
- Labour cost
- Factory overhead cost

Materials

The most important element of cost, the material cost comprises the cost of raw materials, chemicals, components, and consumable stores required for production. It is a function of the quantities in which these materials are required and the prices payable for them.

While estimating the material cost, the following points should be borne in mind:

1. The requirements of various material inputs per unit of output may be established on the basis of one or more of the following: (a) theoretical consumption norms, (b) experience of the industry, (c) performance guarantees, and (d) specification of machinery suppliers.
2. The total requirements of various material inputs can be obtained by multiplying the requirements per unit of output with the expected output during the year.
3. The prices of material inputs are defined in CIF (cost, insurance, and freight) terms.
4. The present costs of various material inputs is considered. In other words, the factor of inflation is ignored. It may be recalled that the factor of inflation is ignored in estimating the sales revenues too.
5. If seasonal fluctuations in prices are regular, the same must be considered in estimating the cost of material inputs.

Utilities

Utilities consist of power, water, and fuel. The requirements of power, water, and fuel may be determined on the basis of the norms specified by the collaborators, consultants, etc. or the consumption standards in the industry, whichever is higher.

The cost of power shown here would include only the cost of bought out power and it may be estimated on the basis of power tariff structure of the concerned electricity boards. The cost of captive power would naturally be reflected in the cost of fuel, etc. The cost payable to local authorities and charges payable to some other firms for water and/or steam supply may be shown separately. Where the entire water requirement is met out of own wells, water charges need not be shown separately. The cost of fuel (furnace oil, coal, firewood, bagasse, etc.) often an important item, is somewhat more difficult to estimate.

Labour

Labour cost is the cost of all manpower employed in the factory. Labour cost naturally is a function of the number of employees and the rate of remuneration. The requirement of workers depends on the number of operators/helpers required for operating various machines and manning various services. The number of supervisory personnel and administrative staff may be calculated on the basis of the general norms prevailing in the industry.

In estimating remuneration rates, the prevailing rates in the industry/area should be taken into account. The remuneration should include, besides basic pay, dearness allowance, house rent allowance, conveyance allowance, medical reimbursement, leave travel concession, provident fund contribution, gratuity contribution, and bonus payments. In addition, account should be taken of vacations, overtime work, night work, work on holidays, etc. Sometimes labour cost is estimated by adding a certain percentage, on a global basis, to the basic pay. It is, however, advisable to make a detailed analysis, at least in the beginning. Labour cost estimates may be raised at the rate of 5 per cent per annum to allow for annual increment, etc.

Labour cost may be calculated for the year in which the maximum capacity utilisation is first achieved. For the earlier years, when the capacity utilisation tends to be low, somewhat lower labour costs, but not proportionately lower in relation to capacity, may be assumed.

Factory Overheads

The expenses on repairs and maintenance, rent, taxes, insurance on factory assets, and so on are collectively referred to as factory overheads. Repairs and maintenance expense depends on the state of the machinery—this expense tends to be lower in the initial years and higher in the later years. Rent, taxes, insurance, etc. may be calculated at the existing rates. A provision should be made for meeting miscellaneous factory expenses. In addition, a contingency margin may be provided on the items of factory overheads.

WORKING CAPITAL REQUIREMENT AND ITS FINANCING

In estimating the working capital requirement and planning for its financing, the following points have to be borne in mind:

1. The working capital requirement consists of the following: (i) raw materials and components (indigenous as well as imported), (ii) stocks of goods-in-process (also referred to as work-in-process), (iii) stocks of finished goods, (iv) debtors, and (v) operating expenses.
2. The principal sources of working capital finance are: (i) working capital advances provided by commercial banks, (ii) trade credit, (iii) accruals and provisions, and (iv) long term sources of financing.
3. There are limits to obtaining working capital advances from commercial banks. They are in two forms: (i) the aggregate permissible bank finance is specified as per the norms of lending, prescribed by the Tandon Committee, (ii) against each current asset a certain amount of margin money has to be provided by the firm.
4. The Tandon Committee[2] has suggested three methods for determining the maximum permissible amount of bank finance for working capital. The method that is generally employed now is the second method. According to this method, the maximum permissible bank finance is calculated as follows:

   Current assets as per the norms laid down by the Tandon Committee (0.75) – Non-bank current liabilities like trade credit and provisions.

   The implication of this norm is that at least 25 per cent of current assets must be supported by long term sources of finance.
5. The margin requirement varies with the type of current asset. While there is no fixed formula for determining the margin amount, the ranges within which margin requirements for various current assets lie are as follows:

Current Assets	*Margin*
Raw materials	10 – 25 per cent
Work-in-process	20 – 40 per cent
Finished goods	30 – 50 per cent
Debtors	30 – 50 per cent

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[2] This committee was set up by the Reserve Bank of India to suggest, *inter alia*, guidelines to commercial banks for working capital financing.

Form IX B of the application form used by the all-India financial institutions, given in Exhibit 6.3, may be used to estimate the working capital requirement, the amount of bank finance available, and the margin money for working capital to be provided from long term sources.

EXHIBIT 6.3

Margin Money for Working Capital

				1 Year *		
Items	**No. of months requirements**	**Bank margin availability**	**Amount**	**Amount of bank finance**	**Margin money required**	**Amount**
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. Indigenous raw materials/ components						
Less Trade credits						
Net indigenous raw materials /components						
2. Imported raw materials/ components						
3. Consumable stores						
Less Trade credit						
Net consumable stores						
4. Wages and salaries						
5. Cost of fuel, light and power, taxes, insurance, rent, etc.						
6. Cost of repairs and maintenance						
7. Packing and sales expenses (other than salaries and wages on sales staff which should be included under 4 above)						
8. Stock of finished goods at cost excluding depreciation (to be held for the period between production and realisation of sale proceeds)						
9. Stock of goods-in-process (cost of production, excluding depreciation during the period taken for one complete cycle, i.e., from the raw material to the finished goods stage)						
10. Outstanding debtors						

Exhibit 6.3 (Continued)

				1 Year *		
Items	No. of months requirements	Bank margin availability	Amount	Amount of bank finance	Margin money required	Amount
(1)	(2)	(3)	(4)	(5)	(6)	(7)
11. Other items of working capital, if any (excise duty payable on 1 month's sale, deposits for utilities etc.)						
Less Trade credits available on raw materials and consumables						
Net working capital**						

Note: 1. The information may be provided for the initial years until the unit reaches maximum capacity utilisation.

2. The amounts given here shall agree with the figures in the profitability statements as well as the cash flow statements.

* Similar information has to be furnished for the II, III, and IV years.

** Advance payments, if any, from customers against orders should be deducted from the net working capital and margin money.

PROFITABILITY PROJECTIONS (OR ESTIMATES OF WORKING RESULTS)

Given the estimates of sales revenues and cost of production, the next step is to prepare the profitability projections or estimates of working results (as they are referred to by term-lending financial institutions in India). The estimates of working results may be prepared along the following lines:

A Cost of production
B Total administrative expenses
C Total sales expenses
D Royalty and know-how payable
E Total cost of production $(A + B + C + D)$
F Expected sales
G Gross profit before interest
H Total financial expenses
I Depreciation
J Operating profit $(G - H - I)$
K Other income

L Preliminary expenses written off
M Profit/loss before taxation ($J + K - L$)
N Provision for taxation
O Profit after tax ($M - N$)
Less Dividend on
– Preference capital
– Equity capital
P Retained profit
Q Net cash accrual ($P + I + L$)

Exhibit 6.4 shows Form XII of the application form used by all-India financial institutions for preparing the estimates of working results.

Cost of Production This represents the cost of materials, labour, utilities, and factory overheads as calculated earlier.

Total Administrative Expenses This consists of (i) administrative salaries, (ii) remuneration to directors, (iii) professional fees, (iv) light, postage, telegrams, and telephones, and office supplies (stationery, printing, etc.), (v) insurance and taxes on office property, and (vi) miscellaneous items.

Total Sales Expenses The expenses included under this head are: (i) commission payable to dealers, (ii) packing and forwarding charges, (iii) salary of sales staff (which may be increased at 5 per cent per annum), (iv) sales promotion and advertising expenses, and (v) other miscellaneous expenses.

The selling expenses depend mainly on the nature of industry and the kind of competitive conditions that prevail. Typically, selling expenses vary between 5 and 10 per cent of sales. The experience of similar firms in the industry may be used as a basic guideline.

Royalty and Know-how Payable Royalty and know-how payable annually may be shown here. The royalty rate is usually 2–5 per cent of sales. Further, royalty is payable often for a limited number of years, say 5 to 10 years.

Total Cost of Production This is simply the sum of cost of production, total administrative expenses, total sales expenses, and royalty and know-how payable.

Expected Sales The figures of expected sales are drawn from the estimates of sales and production prepared earlier in the financial analysis and projection exercise.

Gross Profit Before Interest This represents the difference between expected sales and total cost of production.

Total Financial Expenses Financial expenses consist of interest on term loans, interest on bank borrowings, commitment charges on term loans, and commission for bank guarantees. The principal financial expenses, of course, are interest on term loans and interest on bank borrowings.

In estimating the interest on term loans, two points should be borne in mind: (i) Interest on term loans is based on the present rate of interest charged by the term lending financial institutions and commercial banks. (ii) Interest amount would decrease according to the repayment schedule of term loan.

EXHIBIT 6.4

Estimates of Working Results

(This statement should be prepared for ten years)

(In thousands of rupees)

		Year ending					
		19	19	19	19	19	(ten years)
A	Cost of Production (as per statement in Form XI)						
	Administrative Expenses						
	Administrative salaries						
	Remuneration to directors						
	Professional fees						
	Light, postage, telegrams, and telephones, office supplies (stationery, printing, etc.)						
	Insurance and taxes on office property						
	Miscellaneous						
B	Total Administrative Expenses						
C	Total Sales Expenses						
D	Royalty and Know-how Payable						
E	Total Cost of Production (*A* + *B* + *C* + *D*)						
F	Expected Sales (As per statement in Form XII-A)						
G	Gross Profit Before Interest (*F* – *E*)						
	Financial Expenses						
	Interest on term loans						
	Interest on borrowings for working capital						
	Guarantee commission						
H	Total Financial Expenses						
I	Depreciation						
J	Operating Profit (*G* – *H* – *I*)						
K	Other Income, if any (Give details)						
L	Preliminary Expenses Written Off						
M	Profit/Loss before Taxation (*J* + *K* – *L*)						
N	Provision for Taxation						
O	Profit After Tax (*M* – *N*)						
	Less Dividend on						
	Preference capital						
	Equity capital (with rate)						
P	Retained Profit						
	Add Depreciation						
	Preliminary Expenses Written Off						
Q	Net Cash Accruals						

Note: Detailed working shall be provided for calculation of depreciation (straightline and income tax method), interest, taxation, etc.

The interest on bank borrowings may be estimated as follows: (i) determine the total requirement of the working capital, (ii) find out the quantum of bank borrowing that would be available against the total working capital requirement, and (iii) calculate the interest charges on the basis of the prevailing interest rates.

Depreciation This is an important item, particularly for capital-intensive projects. In figuring out the depreciation charge, the following points should be borne in mind:

1. Contingency margin and pre-operative expenses provided in estimating the cost of project should be added to fixed assets proportionately to ascertain the value of fixed assets for determining the depreciation charge.
2. Preliminary expenses in excess of 2.5 per cent of the project cost (excluding working capital margin) should be added to fixed assets proportionately to ascertain the value of fixed assets for determining the depreciation charge.
3. The Income Tax Act specifies that the written down value method[3] should be used for tax purposes. It further specifies the rate of depreciation applicable to different kinds of assets.
4. For company law (financial reporting) purposes, the method of depreciation may be either the written down value (WDV) method or the straight line (SL) method. From 1988 onwards the depreciation rates under the Companies Act have been delinked from those under the Income Tax Act. The key depreciation rates under the Companies Act are as follows:

In percentage terms

	Single Shift		Double Shift		Triple Shift	
	WDV	*SL*	*WDV*	*SL*	*WDV*	*SL*
1. Buildings (other than factory buildings)	5.00	1.63				
2. Factory buildings	10.00	3.34				
3. Plant and machinery (general rate)	15.00	5.15	22.50	8.09	30.00	11.31

Other Income This represents income arising from transactions not part of the normal operations of the firm. Examples of such transactions are: sale of machinery, disposal of scrap, etc. Except disposal of scrap, which can be reasonably anticipated and estimated, the effects of other non-operating transactions can hardly be estimated. Of course, when non-operating transactions result in a deficit, other income would be negative—put differently, there will be a non-operating loss.

Write-off of Preliminary Expenses Preliminary expenses up to 2.5 per cent of the cost of project or capital employed, whichever is higher, can be amortised in ten equal annual instalments.

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[3] According to the written down value method, the depreciation charge is a certain percentage of the written down value of the asset. For example, if an asset costs Rs 1 million and the depreciation rate for it is 10 per cent, the depreciation charge for the first year would be Rs 100,000, the depreciation charge for the second year would be Rs 90,000 (10 per cent of Rs 9,00,000, the written down value after one year), so on and so forth. In general terms, the depreciation charge for the *n*th year is:

$$D_n = I\ (1-d)^{n-1}\ d \qquad (1)$$

where D_n = depreciation charge for the *n*th year
I = initial cost
d = depreciation rate

Profit/Loss Before Taxation This is equal to: operating profit + other income – write-off of preliminary expenses.

Provision for Taxation To figure out the tax burden, a sound understanding of the Income Tax Act—a complicated legislation—and relevant case laws is required. While calculating the taxable income, a variety of incentives and concessions have to be taken into account. Once the taxable income, as per the Income Tax Act, is calculated, the tax burden can be figured out fairly easily by applying the appropriate tax rates. Details pertaining to tax calculation are discussed in an appendix at the end of the book.

Profit After Taxation This is simply profit/loss before taxation minus provision for taxation. A part of profit after tax is usually paid out as dividend—dividend on preference capital and dividend on equity capital.

Retained Profit The difference between profit after tax and dividend payment is referred to as retained profit. It is also called ploughed back earnings.

Net Cash Accrual The net cash accrual from operations is equal to: retained profit + depreciation + write-off of preliminary expenses + other non-cash charges.

BREAK-EVEN POINT

The profitability projections or estimates of working results discussed above, are based on the assumption that the project would operate at given levels of capacity utilisation in future. In addition to knowing what the projected profits would be at certain levels of capacity utilisation, it is also helpful to know what the level of operation should be to avoid losses. For this purpose, the break-even point, which refers to the level of operation at which the project neither makes profit nor incurs loss is calculated.

As a first step in computing the break-even point, the costs are divided into two broad categories, fixed costs and variable costs, which may be defined as follows:

Fixed Costs Almost every business incurs certain costs which are fixed in nature. These costs remain constant irrespective of changes in the volume of output. They may represent depreciation charge, property tax, insurance, and rent; they may consist of salaries paid to employees; they may consist of interest burden on long-term debt. Fixed costs arise as a result of capacity creation and are invariant with respect to changes in the level of activity (or the level of capacity utilisation). They are essentially a function of time.

Variable Costs Several important elements of costs vary directly with output. For example, the material cost is a function of output. Likewise, the cost of power and other utilities may vary directly with output. All such costs which vary proportionately with output are referred to as variable costs.

Once costs are segregated into fixed costs and variable costs, the break-even point is calculated as follows:

$$\text{Break-even point} = \frac{\text{Fixed costs}}{\text{Unit selling price} - \text{Unit variable cost}}$$

For example, if the fixed costs are Rs 15 million, unit selling price Rs 250 and unit variable cost Rs 150, the break-even point works out to:

$$\frac{\text{Rs 15 million}}{\text{Rs 250} - \text{Rs 150}} = \text{1,50,000 units}$$

Break-even Point for a New Project

In the case of a new project where the capacity utilisation level is expected to rise gradually over a period of 3 to 4 years, fixed costs are normally planned in such a way that they are stepped up as and when necessary to meet the projected increases in capacity utilisation. Hence, the calculation of the break-even point for a new project must be with reference to the fixed costs expected to be incurred in the third year or fourth year when the project is supposed to reach the rated capacity utilisation level. To illustrate this point, consider the case of a new project being set up by Alpha Limited, incorporated recently for this purpose. Alpha Limited plans to utilise 40 per cent of its capacity in the first year, 60 per cent in the second year, and 90 per cent (the rated utilisation level) in the third year. As the firm is likely to attain a stable level of production in the third year, the break-even point may be calculated meaningfully on the basis of estimates for the third year which are given in Exhibit 6.5.

EXHIBIT 6.5

Alpha Limited—Estimates for the Third Year of Production

A	Sales Realisation (180,000 units @ Rs 150)		Rs 2,70,00,000
B	Variable Costs		1,20,00,000
	– Raw materials	Rs 81,00,000	
	– Consumable stores	20,00,000	
	– Power, fuel, water etc.	10,00,000	
	– Selling expenses	9,00,000	
C	Fixed Costs		80,00,000
	– Wages and salaries	Rs 30,00,000	
	– Repairs and maintenance	3,00,000	
	– Depreciation	16,00,000	
	– Rent, insurance, etc.	2,00,000	
	– Administrative expenses	8,00,000	
	– Interest	21,00,000	
D	Contribution (*A* – *B*)		1,50,00,000

On the basis of the estimates given in Exhibit 6.4, the break-even point may be calculated in terms of the volume of production, installed capacity, and sales revenues.

$$\text{Break-even point (in terms of volume of production)} = \frac{\text{Fixed costs}}{\text{Contribution}} \times \text{Expected production in the year}$$

$$= \frac{80,00,000}{1,50,00,000} \times 180,000$$

$$= 96,000 \text{ units}$$

$$\text{Break-even point (in terms of percentage of installed capacity)} = \frac{\text{Fixed costs}}{\text{Contribution}} \times \text{Expected capacity utilisation in the year}$$

$$= \frac{80,00,000}{1,50,00,000} \times 90\ \%$$

$$= 48 \text{ per cent}$$

$$\text{Break-even point of sales (in terms of rupees)} = \frac{\text{Fixed costs}}{\text{Contribution}} \times \text{Expected sales realisation in the year}$$

$$= \frac{80,00,000}{1,50,00,000} \times 2,70,00,000$$

$$= \text{Rs } 1,44,00,000$$

PROJECTED CASH FLOW STATEMENTS

The cash flow statement shows the movement of cash into and out of the firm and its net impact on the cash balance with the firm. The format for preparing the cash flow statement, which is really a cash flow budget, as prescribed by the all-India financial institutions is shown in Exhibit 6.6. While this format calls for preparing the cash flow statement on a half-yearly basis for the construction period and an annual basis for the operating period (for ten years) for managerial purposes, it may be helpful to prepare it on a quarterly basis for the construction period and half-yearly basis for the first 2 to 3 operating years for managerial purposes. This would facilitate better financial planning, project evaluation, and fund control.

EXHIBIT 6.6

Cash Flow Statement

Sources of Funds

1 Share issue
2 Profit before taxation with interest added back
3 Depreciation provision for the year
4 Development rebate reserve
5 Increase in secured medium and long-term borrowings for the project
6 Other medium/long-term loans
7 Increase in unsecured loans and deposits
8 Increase in bank borrowings for working capital
9 Increase in liabilities for deferred payment (including interest) to machinery suppliers
10 Sale of fixed assets
11 Sale of investments
12 Other income (indicate details) Total (*A*)

Disposition of Funds

1 Capital expenditure for the project
2 Other normal capital expenditure
3 Increase in working capital*
4 Decrease in secured medium and long-term borrowings
  – All India Institutions
  – SFCs
  – Banks
5 Decrease in unsecured loans and deposits
6 Decrease in bank borrowings for working capital
7 Decrease in liabilities for deferred payments (including interest) to machinery suppliers
8 Increase in investments in other companies

Exhibit 6.6 (Continued)

9 Interest on term loans
10 Interest on bank borrowings for working capital
11 Taxation
12 Dividends
- Equity
- Preference

13 Other expenditure (indicate details) Total (*B*)
- Opening balance of cash in hand and at bank
- Net surplus/deficit (*A* – *B*)
- Closing balance of cash in hand and at bank

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* Working capital here is defined as: (Current assets other than cash)– (Current liabilities other than bank borrowings)

To illustrate how the projected cash flow statement is prepared let us consider a simple example.

The balance sheet of Bhavishya Enterprises at the end of year *n* (the year which is just over) is as follows:

Liabilities		Assets		
Share capital	100	Fixed assets		180
Reserves and surplus	20	Investments		–
Secured loans	80	Current assets		180
Unsecured loans	50	Cash	20	
Current liabilities	90	Receivables	80	
Provisions	20	Inventories	80	
	360			360

The projected income statement and the distribution of earnings for the year *n* + 1 is given below:

Sales	400
Cost of goods sold	300
Depreciation	20
Earnings before interest and taxes	80
Interest	20
Profit before tax	60
Tax	30
Profit after tax	30
Dividends	10
Retained earnings	20

During the year *n*+1 the firm plans to raise a secured term loan of 20, repay a previous term loan to the extent of 5, and increase unsecured loans by 10. Current liabilities and provisions are expected to remain unchanged. Further, the firm plans to acquire fixed assets worth 30 and increase its inventories by 10. Receivables are expected to increase by 15. Other assets would remain unchanged, excepting, of course, cash. The level of cash would be the balancing amount in the projected balance sheet.

Given the above information, the projected cash flow statement of Bhavishya Enterprises is shown in Exhibit 6.7.

EXHIBIT 6.7

Projected Cash Flow Statement of Bhavishya Enterprises

		Rs in million
Sources of Funds		
Profit before tax with interest added back		8.00
Depreciation		2.00
Increase in secured loans		1.50
Increase in unsecured loans		1.00
	Total (*A*)	12.50
Disposition of Funds		
Capital expenditure		3.00
Increase in working capital		2.50
Interest		2.00
Taxation		3.00
Dividends – Equity		1.00
	Total (*B*)	11.50
Opening balance of cash in hand and at bank		2.00
Net surplus/deficit (*A* – *B*)		1.00
Closing balance of cash in hand and at bank		3.00

PROJECTED BALANCE SHEETS

The balance sheet, showing the balances in various asset and liability accounts, reflects the financial condition of the firm at a given point of time. The format of balance sheet prescribed by the Companies Act is given in Exhibit 6.8.

EXHIBIT 6.8

Format of Balance Sheet Prescribed by the Companies Act

Liabilities	Assets
Share capital	Fixed assets
Reserves and surplus	Investments
Secured loans	Current assets, loans and advances
Unsecured loans	Miscellaneous expenditures and losses
Current liabilities and provisions	

The liabilities side of the balance sheet shows the sources of finance employed by the business. A word about its components shown on the left hand side of Exhibit 6.8 is in order. *Share capital* consists of paid-up equity and preference capital. *Reserves and surplus* represent mainly the accumulated retained earnings. They are shown in different accounts like the capital reserve, the investment allowance reserve, and the general reserve. *Secured loans* represent the borrowings of the firm against which security has been provided. The important components of secured loans are debentures, term loans from financial institutions, and loans from commercial banks. *Unsecured loans* represent borrowings against which no specific security has been provided. The important constituents are: fixed deposits from public and unsecured loans from promoters. *Current liabilities* are obligations which mature in the near future, usually a year. These obligations arise mainly from items which enter the operating cycle: payables from acquiring materials and supplies used in production, and accruals of wages, salaries, and rentals. *Provisions* include mainly tax provision, provision for provident fund, provision for pension and gratuity, and provision for proposed dividends.

The assets side of the balance sheet shows how funds have been used in the business. The major asset components may be described briefly. *Fixed assets* are tangible long-lived resources ordinarily used for producing goods and services. They are shown at original cost less depreciation. *Investments* represent financial securities owned by the firm. *Current assets, loans and advances* consist of cash, debtors, inventories of different kinds, and loans and advances made by the firm. *Miscellaneous expenditures and losses* represent outlays not covered by the previously described asset accounts and accumulated losses, if any.

For preparing the projected balance sheet at the end of year $n + 1$, we need information about the following:

- the balance sheet at the end of year n
- the projected income statement and the distribution of earnings for the year $n + 1$
- the sources of external financing proposed to be tapped in the year $n + 1$
- the proposed repayment of debt capital (long-term, intermediate term, and short-term) during the year $n + 1$
- the outlays and the disposal of fixed assets during the year $n + 1$
- the changes in the level of current assets during the year $n + 1$
- the changes in other assets and certain outlays like preoperative and preliminary expenses (which are capitalised) during the year $n + 1$
- the cash balance at the end of year $n + 1$.

Illustration

By way of illustration, the projected balance sheet of Bhavishya Enterprises may be prepared. Based on the information provided in the previous section (where we introduced Bhavishya Enterprises) the projected balances in various asset and liability accounts are worked out in Exhibit 6.9.

EXHIBIT 6.9

Projected Balances in Liabilities and Assets Accounts

Account category	Opening balance	Changes during the year	Closing balance
Liabilities			
Share capital	100	–	100
Reserves and surplus	20	+ 20(Retained earnings)	40
Secured loans	80	+ 20(Additional term loan) – 5 (Repayment)	95

Exhibit 6.9 (Continued)

Unsecured loans	50	+ 10(Proposed increase)	60
Current liabilities	90	–	90
Provisions	20	–	20
			405
Assets			
Fixed assets	180	+ 30 (Additional outlay) – 20 (Depreciation)	190
Investments	–		–
Current assets	180		215
Cash	20		30*
Inventories	80	+ 10 (Proposed increase)	90
Receivables	80	+ 15 (Expected increase)	95
		Total	405

* This is the balancing item.

MULTI-YEAR PROJECTIONS

Having learnt the basics of projection, we shall now look at an illustration wherein financial projections are made over a longer time frame.

A new firm, ABC Limited, is being set up to manufacture alloy steel. The expected outlays and proposed financing during the construction and the first two operating years are shown in Exhibit 6.10.

EXHIBIT 6.10

Proposed Outlays and Financing of ABC Limited

(Rs in million)

	Construction period	1st operating year	2nd operating year
Outlays			
Preliminary and preoperative expenses	2	–	–
Fixed assets	20	20	10
Current assets (other than cash)	–	20	10
Financing			
Share capital	10	15	–
Term loan	15	15	7.5
Short-term bank borrowing	–	12	6

The projected revenues and costs for the first two operating years are shown in Exhibit 6.11. It may be assumed that (i) the tax rate for the firm will be 60 per cent, (ii) no deductions (reliefs) are available, (iii) preliminary and pre-operative expenses will be written off during the first two operating years, and (iv) no dividend will be paid in the first two operating years.

EXHIBIT 6.11

Projected Revenues and Costs

(Rs in million)

	1st operating year	2nd operating year
Sales	30	60
Cost of sales (excluding interest and depreciation)	30	40
Interest	4.8	6.4
Depreciation	2	2.8

Based on the above information, the projected profit and loss statements, projected cash flow statements, and projected balance sheets may be prepared as shown in Exhibits 6.12, 6.13, and 6.14.

EXHIBIT 6.12

Projected Profit and Loss Statements of ABC Limited

(Rs in million)

	1st operating year	2nd operating year
Sales	30	60
Cost of sales (excluding depreciation and interest)	30	40
Interest	4.8	6.4
Depreciation	2	2.8
Losses (absorbed)	–	6.8
Profit before tax	6.8	4
Tax	–	2.4
Profit after tax	6.8	1.6

EXHIBIT 6.13

Projected Cash Flow Statements for ABC Limited

(Rs in million)

	Construction period	1st operating year	2nd operating year
Sources of Funds			
Share issue	10	15	
Profit before taxation and interest added back*		(2)	17.2

Exhibit 6.13 (Continued)

(Rs in million)

	Construction period	1st operating year	2nd operating year
Depreciation provision for the year		2	2.8
Increase in secured medium and long-term borrowings for the project	15	15	7.5
Increase in bank borrowings for working capital	–	12	6
Total *(A)*	25	42	33.5
Disposition of Funds			
Capital expenditure for the project	20	20	10
Increase in working capital	–	20	10
Interest	–	4.8	6.4
Other expenditure (preliminary and preoperative expenses)	2	–	–
Taxes	–	–	2.4
Total *(B)*	22	44.8	28.8
Opening balance of cash in hand and at cash at bank	–	3	0.2
Net surplus/deficit *(A – B)*	3	(2.8)	4.7
Closing balance of cash in hand and at bank	3	0.2	4.9

* This does, of course, take into account losses absorbed.

EXHIBIT 6.14

Projected Balance Sheets of ABC Limited

(Rs in million)

Liabilities	End of construction period	End of 1st operating year	End of 2nd operating year	Assets	End of construction period	End of 1st operating year	End of 2nd operating year
Share capital	10	25	25	Fixed assets	20	38	45.2
Reserves and surplus			1.6	Current assets			

Exhibit 6.14 (Continued)

(Rs in million)

Liabilities	End of construction period	End of 1st operating year	End of 2nd operating year	Assets	End of construction period	End of 1st operating year	End of 2nd operating year
Secured loan				Cash	3	0.2	4.9
Term loan	15	30	37.5	Others	–	20	30
				Miscellaneous expenditures and losses			
Short-term bank borrowings	–	12	18				
				Preliminary and pre-operative expenses	2	2	2
				Profit and loss account balance	–	6.8	–
	25	67	82.1		25	67	82.1

SUMMARY

- To judge a project from the financial angle, we need information about the following: (i) cost of project, (ii) means of financing, (iii) estimates of sales and production, (iv) cost of production, (v) working capital requirement and its financing, (vi) estimates of working results (profitability projections), (vii) break-even point, (viii) projected cash flow statements, and (ix) projected balance sheets.
- The cost of project represents the sum of all items of outlay associated with a project which are supported by long-term funds. It is the sum of outlays on the following: (i) land and site development, (ii) buildings and civil works, (iii) plant and machinery, (iv) technical know-how and engineering fees, (v) expenses on foreign technicians and training of Indian technicians abroad, (vi) miscellaneous fixed assets, (vii) preliminary and capital issue expenses, (viii) pre-operative expenses, (ix) provision for contingencies, (x) margin money for working capital, and (xi) initial cash losses.
- To meet the cost of project, the following sources of finance (referred to commonly as the means of finance) may be available: share capital (equity capital and preference capital), term loans (rupee term loans and foreign currency term loans), debenture capital (non-convertible debentures and convertible debentures), deferred credit, incentive sources (seed capital assistance, capital subsidy, and tax deferment or exemption), and miscellaneous sources (unsecured loans, public deposits, and lease and hire purchase finance).

- To determine the specific means of finance for a given project, the following should be borne in mind: (i) norms of regulatory bodies and financial institutions and (ii) key business considerations, namely, cost, risk, control, and flexibility.
- Typically, the starting point for profitability projections is the forecast for sales revenues. In estimating sales it is reasonable to assume that capacity utilisation would be somewhat low in the first year and rise thereafter gradually to reach the maximum level in the third or fourth year of operation.
- The major components of cost of production are: material cost, utilities cost, labour cost, and factory overhead cost. The material cost comprises the cost of raw materials, chemicals, components, and consumable stores required for production. The cost of utilities is the sum of the cost of power, water, and fuel. The labour cost includes the cost of all manpower employed in the factory. The expenses on repairs and maintenance, rent, taxes and insurance on factory assets, and so on are collectively referred to as factory overheads.
- In estimating the working capital requirement and planning for its financing, the following must be borne in mind: the build up of current assets till the rated level of capacity utilisation is reached, the maximum permissible bank finance as per the second method of lending recommended by the Tandon Committee, and the margin requirements against various current assets.
- The profitability projections or estimates of working results (as they are referred to by term-lending financial institutions) are proposed along the following lines: (i) cost of production, (ii) total administrative expenses, (iii) total sales expenses, (iv) royalty and know-how payable, (v) total cost of production, (vi) expected sales, (vii) gross profit before interest, (viii) total financial expenses, (ix) depreciation, (x) operating profit, (xi) other income, (xii) preliminary expenses written off, (xiii) profit/loss before taxation, (xiv)provision for taxation, (xv) profit after tax, (xvi) dividend, (xvii) retained profit, and (xviii) net cash accrual.
- The break-even point, which refers to the level of operation at which the project neither makes profit nor incurs loss, is calculated as follows:

$$\frac{\text{Fixed Costs}}{\text{Unit selling price} - \text{Unit variable cost}}$$

- The cash flow statement shows the movement of cash into and out of the firm and its net impact on the cash balance with the firm.
- The balance sheet, showing the balances in various asset and liability accounts, reflects the financial condition of the firm at a given point of time.

QUESTIONS

1. Show how various financial estimates and projections are inter-related.
2. What are the components of cost of project? Discuss them in detail.
3. Describe briefly the various means of financing a project.
4. Discuss the key business considerations relevant for project financing decision.
5. What considerations should be borne in mind while estimating sales revenues?
6. Discuss in detail the major components of cost of production.

7. What points should be kept in mind while estimating the working capital requirement and planning for its financing?
8. Discuss the items that are considered in estimating the working results.
9. What is the break-even point? How is it calculated for a new project?
10. What are the items found in the cash flow statement?
11. Discuss the contents of the balance sheet.

PROBLEMS

1. A new project is being set up by Beta Limited, which has been incorporated recently. Beta Limited plans to utilise 50 per cent of its capacity in the first year, 60 per cent in the second year, and 90 per cent (the rated utilisation level) in the third year. The estimates for the third year are given below:

A.	Sales realisation	(90,000 units @ Rs 200)	Rs 18,000,000
B.	Variable costs		Rs 8,100,000
C.	Fixed costs		Rs 6,000,000
D.	Contribution		Rs 9,900,000

Calculate the break-even point in terms of volume of production, installed capacity, and sales revenues.

2. The balance sheet of Swaraj Limited at the end of year *n* (the year which is just over) is as follows:

(Rs in million)

Liabilities		Assets	
Share capital	5	Fixed assets	11
Reserves and surplus	4	Investments	0.5
Secured loans	4	Current assets	11.5
Unsecured loans	3	* Cash	1
Current liabilities	6	* Receivables	4
Provisions	1	* Inventories	6.5
	23		23

The projected income statement and the distribution of earnings is given below:

(Rs in million)

Sales	25
Cost of goods sold	19
Depreciation	1.5
Earnings before interest and taxes	4.5

Interest	1.2
Profit before tax	3.3
Tax	1.8
Profit after tax	1.5
Dividends	1.0
Retained earnings	0.5

During the year *n*–1, the firm plans to raise a secured term loan of Rs 1 million, repay a previous term loan to the extent of Rs 0.5 million. Current liabilities and provisions would increase by 5 per cent. Further, the firm plans to acquire fixed assets worth Rs 1.5 million and raise its inventories by Rs 0.5 million. Receivables are expected to increase by 5 per cent. The level of cash would be the balancing amount in the projected balance sheet.

Given the above information, prepare the following:

1. Projected cash flow statement
2. Projected balance sheet
3. Hitek Limited is being set up to manufacture plastic window frames. The expected outlays and proposed financing during the construction and the first operating year are shown below:

Outlays	**Construction period**	**1st operating year**
Land	120	–
Building	630	–
Plant and machinery	2700	–
Miscellaneous fixed assets	450	–
Preliminary expenses	150	–
Pre-operative expenses	600	–
Current assets (other than cash)	–	2400
	4650	2400
Financing		
Equity capital	1800	
Term loan	3000	600
Short-term bank borrowing	–	1800
	4800	2400

The following information is available:

(a) The construction period will last for one year, beginning on 1st April of year *n* and ending on 31st March of year *n*+1.

(b) The first operating period will begin on 1st April of year *n*+1 and end on 31st March of year *n*+2.

(c) The term loan will carry an interest of 20 per cent. It is repayable in 16 equal semi-annual instalments after a grace period of 2 years. The interest on term loan during the construction period is included in *pre-operative expenses*. The term loan financing of 600 in the *first operating period* will occur right in the beginning of that year.

(d) Short-term bank borrowing of 1800 will occur right in the beginning of the first operating year. It will carry an interest rate of 18 per cent.

(e) Pre-operative expenses may be allocated to land, building, plant and machinery, and miscellaneous fixed assets in proportion of their values.

(f) The expected revenues and cost of sales (excluding depreciation, other amortisation, and interest) for the first operating year are 4500 and 3000 respectively.

(g) The depreciation rates for company law purposes will be as follows:

Building	. . .	3.34 per cent
Plant and machinery	. . .	8.09 per cent
Miscellaneous fixed assets	. . .	8.09 per cent

(h) There will be no tax liability for the first operating year.

Given the above information, complete the following projected statements:

Projected Income Statement for the 1st Operating Year

Sales	4500
Cost of sales	3000
Depreciation	–
Interest	–
Write off of preliminary expenses	15
Net profit	–

Projected Cash Flow Statements

Sources	Construction period	1st operating year
Share capital	1800	...
Term loan	3000	...
Short-term bank borrowing		...
Profit before interest and tax		...
Depreciation		...
Write off of preliminary expenses		...
	4800	...
Uses		
Capital expenditure	3900	...
Current assets (other than cash)	–	...

Sources	Construction period	1st operating year
Preliminary expenses	150	...
Pre-operative expenses	600	...
Interest	–	...
	4650	...
Opening cash balance	0	...
Net surplus/deficit	150	...
Closing balance	150	...

Projected Balance Sheets

Liabilities	31/3/n+1	31/3/n+2	Assets	31/3/n+1	31/3/n+2
Share Capital	1800	...	Fixed Assets (Net)	4500	...
Reserves and Surplus	–	...			
Secured Loans:			Current Assets:		
– Term loan	3000	...	– Cash	150	...
– Short-term bank borrowing		...	– Other Current Assets		...
Unsecured Loans	–	...			
Current Liabilities and Provisions	–	...	Miscellaneous Expenditures and Losses		
			– Preliminary Expenses	150	...
	4800	...		4800	...

APPENDIX 6A

VEGETRON LIMITED: A CASE STUDY ON FINANCIAL PROJECTIONS

Background

Vegetron Limited is a newly set up public limited company, promoted by Mr. Muthiah, Mr. Balasubramaniam, and Mr. Krishna. Mr. Muthaiah, the managing director of the company, is a food technologist with over twenty years of experience in some of the well-known companies in the food sector. Mr. Balasubramaniam, the finance director, is a qualified chartered accountant with over twenty five years of industrial experience. Mr. Krishna, the marketing director, has over fifteen years of experience in marketing food products.

Vegetron proposes to set up a plant to manufacture Textured Vegetable Protein (TVP), at a location not far from Bangalore. TVP is a high protein instant food mix, which is considered to be a substitute for meat. Due to its texture, TVP has appeal to both vegetarians and non-vegetarians. So it is expected to enjoy a growing market. There are only two other units in the country manufacturing TVP, located near Bhopal and Delhi. Both of them are now doing reasonably well, though they had some problems initially.

Technical and Marketing Aspects

The process know-how for TVP is proposed to be supplied by Spectra Machines Private Limited, a project engineering company, which will supply the main extrusion plant. The indigenous extrusion plant developed by Spectra Machines is a cost-effective alternative to imported extrusion plants. While the extrusion plant of Spectra Machines costs Rs 5.5 million, a similar imported plant costs Rs 9 million (inclusive of customs duty). Spectra Machines have supplied similar plants to the other two manufacturers of TVP and they are running satisfactorily. Vegetron proposes to give a turn-key contract to Spectra Machines that covers supply and commissioning of the unit along with a guarantee for a satisfactory trial run for a consideration of Rs 6.2 million. A condition will stipulate that the last 25 per cent of the amount is to be released only after a satisfactory trial run.

Vegetron will require about 2000 TPA (tonnes per annum) of defatted soya as the raw material at its optimum capacity utilisation. Enquiries in Bhopal, which is the major centre for defatted soya, suggest that there is no problem whatsoever in procuring this quantity.

Vegetron plans to market its product in two forms: bulk TVP and branded TVP. While the former is sold as a commodity the latter is marketed as a branded product. The bulk TVP requires very little marketing effort as well as expenses but the margin on its sales is low. The branded TVP, on the other hand, entails considerable marketing effort and expenditure and the margin on its sales is high. It is expected that the revenues from bulk TVP and branded TVP will be in the ratio 80:20. Given this mix, the sales expenses are expected to be 10 per cent of net sales.

Cost of Project and Means of Finance

The cost of the project is estimated at Rs 11.44 million as follows:

	(Rs in million)
Land and site development	0.39
Building	1.50
Plant and machinery	6.20
Miscellaneous fixed assets	0.40
Preliminary expenses	0.20
Pre-operative expenses (including interest during construction)	1.15
Contingency margin	0.75
Working capital margin	0.85
	11.44

The proposed means of finance for the project are as follows:

	(Rs in million)
Share capital	4.0
Term loans	6.4
State governments' special incentive loan (Repayable in 6 instalments after 12 years)	1.04
	11.44

The discussions with state level financing agencies and a commercial bank suggest that it should be feasible to get term loans and working capital finance for the project.

Basic Assumptions Underlying Financial Projections

The profitability and other projections may be prepared on the basis of the following assumptions:

1. The construction period will last for one year.
2. The company would work for 300 days per year on a 2 shift basis. The installed capacity on this basis works out to 2880 TPA.
3. The company will start commercial production on April 1, 19X0. The expected capacity utilisation will be 50 per cent in the first year, 60 per cent in the second year, and 70 per cent for the third year and beyond.
4. The average sales realisation per kilogramme of TVP will be Rs 12, net of excise duty.
5. The cost of raw materials and consumables will be 65 per cent of sales; the cost of power will be 4 per cent of sales.
6. Wages and salaries are expected to be Rs 0.9 million, Rs 1 million, and Rs 1.2 million for the first, second, and third operating years. Thereafter, they would rise at the rate of 5 per cent per year.

7. Factory overhead expenses will be Rs 50,000 for the first year. They will increase at the rate of 6 per cent per year subsequently.
8. Administration expenses will be Rs 100,000 per year.
9. Selling expenses will be 10 per cent of sales.
10. The term loan will be repaid in 16 equal half-yearly instalments, with the first instalment falling due at the end of the second operating year. The interest rate on the outstanding term loan will be 14 per cent.
11. The current asset requirements are expected to be as follows:

Raw materials (including consumables)	: 1.50 months
Stock-in-process	: 0.03 month
Finished goods	: 0.50 month
Book debt	: 1.00 month

12. The suppliers of raw materials and consumables will provide trade credit for half a month.
13. The bank finance for working capital will cost 18 per cent.
14. The depreciation rates for company law purposes will be as follows:

Building	: 3.34 per cent
Plant and machinery	: 8.09 per cent
Miscellaneous fixed assets	: 5.15 per cent

15. The depreciation rates for income tax purposes will be as follows, under the written down value method:

Building	: 10 per cent
Plant and machinery and miscellaneous fixed ssets	: 33.3 per cent

16. The preliminary expenses may be written off in 10 equal annual instalments.
17. Vegetron Limited is a domestic company in which the public are not substantially interested.
18. The firm plans to pay dividend from the second year. The dividend rate is proposed to be 12 per cent for the second year. Thereafter, it would be enhanced by 2 per cent every alternate year.

In order to prepare the profitability estimates (estimates of working results), the projected cash flow statements, and the projected balance sheets, we need information about

(a) interest on term loan,
(b) working capital requirements, and
(c) depreciation schedule.

This is developed in Exhibits 6A.1, 6A.2, and 6A.3 respectively.

Putting together all the above information, the following projections have been prepared:

Exhibit 6A.4 : Profitability Estimates
Exhibit 6A.5 : Tax Calculation
Exhibit 6A.6 : Projected Cash Flow Estimates
Exhibit 6A.7 : Projected Balance Sheets

EXHIBIT 6A.1

Interest on Term Loans

(Rs in million)

Year	Loan o/s at the beginning	Loan o/s at the end of the first half year	Loan o/s at the end of the second half year	Int. for the first half year	Int. for the second half year	Total int. for the term loan
I	6.4	6.4	6.4	0.45	0.45	0.90
II	6.4	6.4	6.0	0.45	0.45	0.90
III	6.0	5.6	5.2	0.42	0.40	0.81
IV	5.2	4.8	4.4	0.36	0.34	0.70
V	4.4	4.0	3.6	0.31	0.28	0.59
VI	3.6	3.2	2.8	0.25	0.22	0.48
VII	2.8	2.4	2.0	0.20	0.17	0.36
VIII	2.0	1.6	1.2	0.14	0.11	0.25
IX	1.2	0.8	0.4	0.08	0.06	0.14
X	0.4	–	–	0.03	–	0.03

EXHIBIT 6A.2

Working Capital Requirements

(Rs in million)

Item	Norms in months	I year	II year	III year
1. Raw Materials (including consumables)	0.15	1.40	1.67	1.97
2. Stock-in-Process	0.03	0.03	0.04	0.04
3. Finished Goods	0.05	0.52	0.62	0.75
4. Book Debts *	0.10	1.44	1.73	2.02
Total Current Assets		3.39	4.06	4.78
Less Margin for Working Capital from Long-term Sources (25% of Total Current Assets)		0.85	1.02	1.20
Less Trade Credit for Raw Materials and Consumable Stores	0.05	0.47	0.56	0.66
Bank Finance for Working Capital		2.07	2.48	2.92

* Book debts include excise duty. However, for the sake of simplicity we have ignored excise duty here.

EXHIBIT 6A.3

Depreciation Schedules

(Rs in million)

A Asset Valuation for Depreciation Purposes

Asset	Basic cost	Share of preoperative expenses	Share of contingency margin	Total cost
Land	0.39	0.05	0.03	0.47
Building	1.50	0.20	0.13	1.83
Plant and machinery	6.20	0.84	0.55	7.59
Miscellaneous fixed assets	0.40	0.05	0.04	0.49

B Depreciation Schedule for Company Law Purposes (Straight Line Method)

Building (3.34%) : 0.061

Plant and machinery (8.09%) : 0.614

Miscellaneous fixed assets (5.15%) : 0.025

Annual depreciation : 0.700

C Depreciation Schedule for Income Tax Purposes (Written Down Value Method)

	I	II	III	IV	V	VI	VII	VIII	IX	X
Building (10%)	0.183	0.165	0.148	0.133	0.120	0.108	0.097	0.088	0.079	0.071
Plant and machinery and misc. fixed assets (33 1/3%)	2.693	1.795	1.197	0.798	0.532	0.355	0.236	0.158	0.105	0.070
Total	2.876	1.960	1.345	0.931	0.652	0.463	0.333	0.246	0.184	0.141

EXHIBIT 6A.4

Profitability Estimates (Estimates of Working Results)

(Rs in million)

	I Year	II Year	III Year	IV Year	V Year	VI Year	VII Year	VIII Year	IX Year	IX Year
Installed Capacity (TPA)	2880	2880	2880	2880	2880	2880	2880	2880	2880	2880
Production (TPA)	1440	1728	2016	2016	2016	2016	2016	2016	2016	2016
Capacity Utilisation	50%	60%	70%	70%	70%	70%	70%	70%	70%	70%
A Sales Realisation	17.28	20.74	24.19	24.19	24.19	24.19	24.19	24.19	24.19	24.19
B Cost of Production										
• Raw materials	11.23	13.48	15.72	15.72	15.72	15.72	15.72	15.72	15.72	15.72
• Power	0.69	0.83	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
• Wages & salaries	0.90	1.00	1.20	1.26	1.32	1.39	1.46	1.53	1.61	1.69
• Factory overheads	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.08	0.08
C Administration and Selling Expenses										
• Administration expenses	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
• Selling expenses	1.73	2.07	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42
D Gross Profit Before Interest	2.58	3.21	3.72	3.66	3.60	3.53	3.45	3.38	3.29	3.21
E Total Financial Expenses										
• Interest on term loans	0.90	0.90	0.81	0.70	0.59	0.48	0.36	0.25	0.14	0.03
• Interest on bank borrowing	0.37	0.45	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
F Depreciation	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
G Operating Profit	0.61	1.16	1.68	1.73	1.78	1.82	1.86	1.90	1.92	1.95
H Preliminary Expenses Written off	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
I Profit/Loss Before Tax	0.59	1.14	1.66	1.71	1.76	1.80	1.84	1.88	1.90	1.93
*J Provision for Tax**	–	–	–	0.25	0.57	0.64	0.70	0.73	0.76	0.78
K Profit after Tax	0.59	1.14	1.66	1.46	1.19	1.16	1.14	1.15	1.14	1.15
L Less:	–	0.48	0.48	0.56	0.56	0.64	0.64	0.72	0.72	0.80
M Retained Profit	0.59	0.66	1.18	0.90	0.63	0.52	0.50	0.43	0.42	0.35
N Add: Depreciation	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Preliminary expenses written off	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
O Net Cash Accruals	1.31	1.38	1.90	1.62	1.35	1.24	1.22	1.15	1.14	1.07

* The details of tax calculation are shown in Exhibit 6A.5

EXHIBIT 6A.5

Tax Calculation

(Rs in million)

	I Year	II Year	III Year	IV Year	V Year	VI Year	VII Year	VIII Year	IX Year	X Year
• Profit/loss before depreciation	0.59	1.14	1.66	1.71	1.76	1.80	1.84	1.88	1.90	1.93
Add depreciation for company law purposes	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
	1.29	1.84	2.36	2.41	2.46	2.50	2.54	2.58	2.60	2.63
Less depreciation for tax purposes	2.88	1.96	1.35	0.93	0.65	0.46	0.33	0.25	0.18	0.14
	(1.59)	(0.12)	1.01	1.48	1.81	2.04	2.21	2.33	2.42	2.49
Less unabsorbed depreciation of earlier years	–	–	1.01	0.70	–	–	–	–	–	–
• Gross total income	–	–	–	0.78	1.81	2.04	2.21	2.33	2.42	2.49
Less deduction for newly set up industrial undertaking under section 80I for 10 years from the initial year @ 30% of gross total income	–	–	–	0.23	0.54	0.61	0.66	0.70	0.73	0.75
• Total income	–	–	–	0.55	1.27	1.43	1.55	1.63	1.69	1.74
• Income tax @ 45 per cent of total income	–	–	–	0.25	0.57	0.64	0.70	0.73	0.76	0.78

* For calculating the income tax only the basic rate is considered. The surcharge has been ignored because it tends to vary from year to year.

EXHIBIT 6A.6

Projected Cash Flow Statements

(Rs in million)

	Construction period	I Year	II Year	III Year	IV Year	V Year	VI Year	VII Year	VIII Year	IX Year	X Year
Sources of Funds											
Share issue	4.00										
• Profit before taxation with interest added back		1.86	2.49	3.00	2.94	2.88	2.81	2.73	2.66	2.57	2.49
• Depreciation		0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
• Preliminary expenses written off		0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
• Increase in secured medium and long-term borrowings	6.40	–	–	–	–	–	–	–	–	–	–
• Increase in bank borrowings for working capital		2.07	0.41	0.44	–	–	–	–	–	–	–
• Increase in the State Govt's Special Incentive Loan	1.04	–	–	–	–	–	–	–	–	–	–
Total (*A*)	11.44	4.65	3.62	4.16	3.66	3.60	3.53	3.45	3.38	3.29	3.21
Disposition of Funds											
• Capital expenditure for the project	10.35	–	–	–	–	–	–	–	–	–	–
• Increase in working capital		2.92	0.58	0.62	–	–	–	–	–	–	–
• Preliminary expenses	0.24	–	–	–	–	–	–	–	–	–	–
• Decrease in secured medium and long-term borrowings		–	0.40	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.40
• Interest on term loans		0.90	0.90	0.81	0.70	0.59	0.48	0.36	0.25	0.14	0.03
• Interest on bank borrowings for working capital		0.37	0.45	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
• Taxation		–	–	–	0.25	0.57	0.64	0.70	0.73	0.76	0.78
• Dividend		–	0.48	0.48	0.56	0.56	0.64	0.64	0.72	0.72	0.80
Total (*B*)	10.59	4.19	2.81	3.24	2.84	3.05	3.09	3.03	3.03	2.95	2.54
• Opening balance of cash in hand and at bank	0	0.85	1.31	2.12	3.04	3.86	4.41	4.85	5.27	5.62	5.96
• Net surplus/deficit (*A*– *B*)	0.85	0.46	0.81	0.92	0.82	0.55	0.44	0.42	0.35	0.34	0.67
• Closing balance of cash in hand and at bank	0.85	1.31	2.12	3.04	3.86	4.41	4.85	5.27	5.62	5.96	6.63

EXHIBIT 6A.7

Projected Balance Sheets

(Rs in million)

	At the end of the construction period	I Year	II Year	III Year	IV Year	V Year	VI Year	VII Year	VIII Year	IX Year	X Year
Liabilities											
• Share Capital	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
• Reserves and Surplus	–	0.59	1.25	2.43	3.33	3.96	4.48	4.98	5.41	5.83	6.18
• Secured Loans											
– Term loan	6.40	6.40	6.00	5.20	4.40	3.60	2.80	2.00	1.20	0.40	–
– Working capital adv.	–	2.07	2.48	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92
• Unsecured Loans											
– State Govt. loan	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
• Current Liabilities and Provisions											
– Trade credit	–	0.47	0.56	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Total	11.44	14.57	15.33	16.25	15.25	16.18	15.90	15.60	15.23	14.85	14.80
Assets											
• Fixed Assets											
– Gross block	10.39	10.39	10.39	10.39	10.39	10.39	10.39	10.39	10.39	10.39	10.39
– Less accumulated depreciation	–	0.70	1.40	2.10	2.80	3.50	4.20	4.90	5.60	6.30	7.00
– Net fixed assets	10.39	9.69	8.99	8.29	7.59	6.89	6.19	5.49	4.79	4.09	3.39
• Investments	–	–	–	–	–	–	–	–	–	–	–
• Current Assets, Loans and Advances											
– Raw materials	–	1.40	1.67	1.97	1.97	1.97	1.97	1.97	1.97	1.97	1.97
– Stock-in-process	–	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
– Finished goods	–	0.52	0.62	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
– Book debts	–	1.44	1.73	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02
– Cash and bank balances	0.85	1.31	2.12	3.04	3.86	4.41	4.85	5.27	5.62	5.96	6.63
• Miscellaneous Expenditure and Losses											
– Preliminary expenses	0.20	0.18	0.16	0.14	0.12	0.10	0.08	0.06	0.04	0.02	–
Total	11.44	14.57	15.33	16.25	15.25	16.18	15.90	15.60	15.23	14.85	14.80

PART 3

SELECTION I: BASIC CONCEPTS AND CRITERIA

Project Cash Flows

Time Value of Money

Cost of Capital

Appraisal Criteria

Analysis of Risk

7

Project Cash Flows

The three basic steps in determining whether a project is worthwhile or not are:

(a) estimate project cash flows,
(b) establish the cost of capital (or hurdle rate), and
(c) apply a suitable decision or appraisal criterion

This chapter presents the framework for estimating project cash flows. Chapters 9 and 10 dwell on the issues of cost of capital and appraisal criteria. Since a discussion of cost of capital and appraisal criteria requires a basic understanding of the concepts of time value of money, the following chapter focusses on these concepts.

The financial costs and benefits of a project, referred to popularly as project cash flows, are defined with the help of inputs provided by marketing, production, engineering, costing, purchase, taxation, and other departments. The role of the financial analyst (or the finance department) is to keep the exercise focused on relevant variables, coordinate the efforts of various participants in this process, ensure that the forecasts are reasonably balanced and internally consistent, and minimise the biases inherent in forecasting. Usually the outcome of this process is a set of projections prepared according to conventional accounting principles. From these statements, the project cash flow stream, consisting of cash outflows and cash inflows, has to be derived. It must be emphasised that our focus is on cash flows, which are different from accounting measures[1]. Cash outflows, not expenses in accounting terms, are the relevant measure of financial costs; likewise, cash inflows, not revenues as determined by accounting conventions, reflect financial benefits.

The discussion on developing project cash flows is divided into six sections as follows:

- Basic principles for measuring project cash flows
- Components of the cash flow stream
- Cash flow illustrations
- Viewing a project from different points of view
- How financial institutions and the planning commission define cash flows
- Biases in cash flow estimation

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[1] It may be noted that accounting statements in some ways mix apples and oranges. For example, accountants deduct wages and salaries, which are cash outflows, from revenues, which may or may not be in cash (a portion of sales may be in credit). More important, depreciation charges, which are not cash outflows, are deducted but capital expenditures, which do involve cash outflows, are not deducted.

BASIC PRINCIPLES FOR MEASURING PROJECT CASH FLOWS

For developing the stream of financial costs and benefits, the following principles must be kept in mind:

- Incremental principle
- Long-term funds principle
- Exclusion of financing costs principle
- Post-tax principle

Incremental Principle

The cash flows of a project must be measured in incremental terms. To ascertain a project's incremental cash flows, one has to look at what happens to the cash flows of the firm *with* the project and *without* the project.[2] The difference between the two reflects the incremental cash flows attributable to the project. That is,

Project cash flow for year t = Cash flow for the firm *with* the project for year t − Cash flow for the firm *without* the project for year t

In estimating the incremental cash flows of a project, the following guidelines must be borne in mind:

1. *Consider All Incidental Effects* In addition to the direct cash flows of the project, all its incidental effects on the rest of the firm must be considered. The project may enhance the profitability of some of the existing activities of the firm because it has a complementary relationship with them; or, it may detract from the profitability of some of the existing activities of the firm because it has a competitive relationship with them—all these effects must be taken into account.
2. *Ignore Sunk Costs* A sunk cost refers to an outlay incurred in the past or already committed irrevocably. So it is not affected by the acceptance or rejection of the project under consideration. Suppose, for example, a company is debating whether it should invest in a project. The company has already spent Rs 1 million for preliminary work meant to generate information useful for this decision. Is this Rs 1 million a relevant cost for the proposed project? Clearly not. Rs 1 million represents a sunk cost as it cannot be recovered irrespective of whether the project is accepted or not. Remember that bygones are bygones and are not relevant for decision making.
3. *Include Opportunity Costs* If a project requires the use of some resources already available with the firm, the opportunity cost of these resources should be charged to the project. The opportunity cost of a resource is the present value of net cash flows that can be derived from it if it were put to its best alternative use. Suppose a project requires a vacant piece of land within the factory premises of the firm. The cost of this land represents a sunk cost and is irrelevant for the new project decision. But the project should be charged with the opportunity cost of this land which represents the benefit that can be derived from it by putting it to its best alternative use, which in this case may simply be leasing the land to another firm.
4. *Question the Allocation of Overhead Costs* Costs which are only indirectly related to a product (or service) are referred to as overhead costs. They include items like

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[2] And not *before* the project and *after* the project as is sometimes done.

general administrative expenses, managerial salaries, legal expenses, rent and so on. Accountants normally allocate these overhead costs to various products on some basis like labour hours or machine hours which appears acceptable. Hence, when a new project is proposed, a portion of the overhead costs of the firm is usually allocated to it. The overhead allocated to it, however, has hardly any relationship with the incremental overhead costs, if any, associated with it. For purposes of investment appraisal what matters is the incremental overhead costs (along with other incremental costs) attributable to the project and not the allocated overhead costs.

Long-term Funds Principle

A project may be evaluated from various points of view: total funds point of view, long-term funds point of view, and equity point of view. The measurement of cash flows as well as the determination of the discount rate for evaluating the cash flows depends on the point of view adopted. It is generally recommended that a project may be evaluated from the point of view of long-term funds (which are provided by equity stockholders, preference stockholders, debenture holders, and term-lending institutions) because the principal focus of such evaluation is normally on the profitability of long-term funds. This argument, though plausible, cannot be regarded as unassailable. Nonetheless, we subscribe to the position that it is quite reasonable to view a project from the long-term funds point of view. Hence for determining the costs and benefits of an investment project we will raise the questions: What is the sacrifice made by the suppliers of long-term funds? What benefits accrue to the suppliers of long-term funds?

The sacrifice made by the suppliers of long-term funds is equal to the outlays on fixed assets and net working capital (it may be recalled that net working capital, which represents the difference between current assets and current liabilities, is supported by long-term funds). The benefits accruing to the suppliers of long-term funds consist of operational cash inflows after taxes and salvage value of fixed assets and net working capital.

Exclusion of Financing Costs Principle

When cash flows relating to long-term funds are being defined, financing costs of long-term funds (interest on long-term debt and equity dividend) should be excluded from the analysis. Why? The weighted average cost of capital used for evaluating the cash flows takes into account the cost of long-term funds. Put differently the interest and dividend payments are reflected in the weighted average cost of capital. Hence, if interest on long-term debt and dividend on equity capital are deducted in defining the cash flows, the cost of long-term funds will be counted twice—an error that should be carefully guarded against.

Operationally, the *exclusion of financing costs* principle means that: (i) the interest on long-term debt (referred to hereafter as just interest for the sake of simplicity) is ignored while computing profits and taxes thereon and (ii) the expected dividends are deemed irrelevant in cash flow analysis. While dividends pose no difficulty as they come only from profit after taxes, interest needs to be handled properly. Since interest is usually deducted in the process of arriving at profit after tax, an amount equal to interest (1-tax rate) should be added back to the figure of profit after tax. To understand the nature of this adjustment, it may be noted that:

Profit before interest and tax (1– tax rate)
= (Profit before tax + interest) (1– tax rate)
= (Profit before tax) (1– tax rate) + (interest)(1– tax rate)
= Profit after tax + interest (1– tax rate)

Thus, whether the tax rate is applied directly to the profit before interest and tax figure or whether the tax-adjusted interest, which is simply interest (1-tax rate), is added to profit after tax we get the same result.

Post-tax Principle

Tax payments like other payments must be properly deducted in deriving the cash flows. Put differently cash flows must be defined in post-tax terms. (It may be noted that the cost of capital employed for evaluating the cash flow stream is also measured in post-tax terms.)

COMPONENTS OF THE CASH FLOW STREAM

The cash flow stream associated with a project may be divided into three basic components: (i) an initial investment, (ii) operating cash inflows, and (iii) a terminal cash flow. The *initial investment* represents the relevant cash outflow when the project is set up. The *operating cash inflows* are the cash inflows that arise from the operation of the project during its economic life. The *terminal cash flow* is the relevant cash flow occurring at the end of the project life on account of liquidation of the project.

Initial Investment

The manner in which the initial investment is defined depends on whether the project is a *new project* or a *replacement project* as shown below:

New project	**Replacement project**
Cost of capital assets	Cost of replacement capital assets
+ Installation costs	+ Installation costs
+ Working capital margin	– Post-tax proceeds from the sale of old capital assets
+ Preliminary and pre-operative expenses	+ Change in working capital margin
– Tax shield, if any, on capital assets	+ Preliminary and preoperative expenses*
	– Tax shield, if any, on replacement capital assets

* This item is usually not applicable to a replacement project.

Operating Cash Inflows

For deriving the operating cash inflows, the projected profitability statements are the starting point. Since there is a difference between the recognition of revenues and expenses in accounting and the incidence of cash flows, a rigorous analysis requires that each item of revenue and expense be examined to find out the cash flows associated with it. For example, the pattern of collection associated with credit sales and the pattern of payments associated with credit purchases have to be analysed. This kind of detailed analysis, however, becomes too unwieldy and cumbersome for real life projects. Moreover, when we are interested in defining the cash flows on a yearly basis, as is done commonly in project appraisal, a significant portion of such detailed analysis is redundant because it helps in getting only a more refined picture of intra-year cash flows. So from a practical point of view, it suffices if depreciation and other non-cash charges, which are deducted in computing profits from the accounting point of view, are added back because they do not result in cash outflows. This means that the operating cash inflow for a given year is defined as follows:[3]

New project	Replacement project
Profit after tax	Change in profit after tax
+	+
Depreciation	Change in depreciation
+	+
Other non-cash charges	Change in other non-cash charges
+	+
Interest on long-term debt (1-tax rate)	Change in interest on long-term debt (1-tax rate)

Terminal Cash Flow

The cash flow resulting from the termination or liquidation of a project at the end of its economic life is called its terminal cash flow. It is defined as follows:

New project	Replacement project
Post-tax proceeds* from the sale of capital assets	Post-tax proceeds from the sale of replacement capital assets
	−
	Post-tax proceeds from the sale of present capital assets
+	+
Net recovery of working capital margin	Net recovery of working capital margin

* Post-tax proceeds are also referred to as the net salvage value.

A word about the two components of the terminal cash flow is in order.

Net Salvage Value of Capital Assets Usually, the sale price of a capital asset exceeds its book value. Therefore, the net salvage value is equal to:

Sale value − Tax, if any, on sale

If, however, a loss is incurred on sale, the net salvage value is equal to:

Sale value − Tax shield, if any, on sale

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[3] The profit after tax figure in these expressions is arrived at by deducting interest on long-term debt. So, the tax-adjusted interest on long-term debt is added back in conformity with the 'exclusion of financial charges' principle.

It is difficult to estimate the sale value of a capital asset as it is influenced by factors like technological innovations, inflation, shifts in demand, and physical wear and tear. In view of these difficulties, an approach that is commonly followed is to assume that the sale value would be equal to either the book value at the time of sale or a small fraction (say 5 per cent) of the original value. Since this approach is rather naive and unrealistic, the following method can be used to get a first approximation of the sale value.

1. Find the ratio of the market price of a machine used for n years (n is the planning horizon) to the market price of a new machine. Denote this by r.
2. Determine the annual compound rate of growth of the price of a new machine over the last five years. Denote this by g.
3. Project the price of new machine after n years using the formula:
$$A(1+g)^n$$
(In this formula A represents the price of the new machine now.)
4. Estimate the sale price of machine (bought new now) after n years of use, employing the formula.
$$A(1+g)^n r$$

An example may be given to illustrate this approach. A firm, having a planning horizon of ten years, is considering the acquisition of a new machine which costs Rs 1.2 million now. (The cost of a similar new machine five years ago was Rs 0.8 million.) The market price of a comparable machine which has been used for ten years is now Rs 0.4 million.

Given the above information, the sale value of a new machine, now bought for Rs 1.2 million, after ten years (the planning horizon) is obtained as follows:

The ratio of the market value of a ten-year old machine to the market value of a new machine is

$$r = \frac{4}{12}$$

The annual compound rate of growth[4] in the price of a new machine is

$$g = \left[\frac{12}{8}\right]^{\frac{1}{5}} - 1 = 0.09$$

In percentage terms it is 9 per cent

The sale price of a new machine after ten years is Rs 1.2 million $(1.09)^{10}$ = Rs 2.84 million

The sale price of a machine (bought new now) after 10 years years of use would be equal to:

$$\text{Rs } 2.84 \text{ million} \times \frac{4}{12} = 0.948 \text{ million}$$

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[4] The equation for g is obtained as follows:

$$8(1+g)^5 = 12$$

$$\text{So} \quad (1+g)^5 = \frac{12}{8}$$

$$(1+g) = \left[\frac{12}{8}\right]^{\frac{1}{5}}$$

$$g = \left[\frac{12}{8}\right]^{\frac{1}{5}} - 1$$

Net Recovery of Working Capital Margin Working capital is normally expected to be liquidated at its face value. Hence no profit or gain is expected from its liquidation. Therefore the net recovery of working capital margin is equated with the working capital margin provided at the outset.

Time Horizon for Analysis

What should be the time horizon for cash flow analysis? The time horizon for cash flow analysis is the minimum of the following:

Physical Life of the Plant This refers to the period during which the plant remains in a physically usable condition, i.e., the number of years the plant would perform the function for which it has been acquired. This depends on the wear and tear which the plant is subject to. Suppliers of plant may provide information on the physical life under normal operating conditions. While the concept of physical life may be useful for determining the depreciation charge, it is not very useful for investment decision making purposes.

Technological Life of the Plant New technological developments tend to render existing plants obsolete. The technological life of a plant refers to the period of time for which the present plant would not be rendered obsolete by a new plant. It is very difficult to estimate the technological life because the pace of new developments is not governed by any law. While it is almost certain that a new development would render the existing plant obsolete, how soon that development would occur is anybody's guess. Yet an estimate of the technological life has to be made.

Product Market Life of the Plant A plant may be physically usable, its technology may not be obsolete, but the market for its products may disappear or shrink and hence its continuance may not be justified. The product market life of a plant refers to the period for which the product of the plant enjoys a reasonably satisfactory market.

Investment Planning Horizon of the Firm The time period for which a firm wishes to look ahead for purposes of investment analysis may be referred to as its investment planning horizon. It naturally tends to vary with the complexity and size of the investment. For small investments (say, installation of a lathe) it may be five years, for medium-size investments (say, expansion of plant capacity) it may be 10 years, and for large-size investments (say, setting up of a new division) it may be 15 years.

CASH FLOW ILLUSTRATIONS

To show how cash flows are defined, bearing in mind the principles discussed above, three illustrations of gradually increasing complexity are presented in this section.

Illustration I

Naveen Enterprises is considering a new investment project about which the following information is available.

1. The total outlay on the project will be Rs 10 million. This consists of Rs 6 million on plant and equipment and Rs 4 million on gross working capital. The entire outlay will be incurred at the beginning of the project.

2. The project will be financed with Rs 4 million of equity capital, Rs 3 million of long term debt (in the form of debentures), Rs 2 million of short-term bank borrowings, and Rs 1 million of trade credit. This means that Rs 7 million of long term funds (equity + long-term debt) will be applied towards plant and equipment (Rs 6 million) and working capital margin (Rs 1 million)—working capital margin is defined as the contribution of long term funds towards working capital. The interest rate on debentures will be 15 per cent and the interest rate on short-term borrowings will be 18 per cent.
3. The life of the project is expected to be 5 years and the plant and equipment would fetch a salvage value of Rs 2 million. The liquidation value of working capital will be equal to Rs 4 million, the book value.
4. The project will increase the revenues of the firm by Rs 6 million per year. The increase in operating expenses on account of the project will be Rs 4 million per year. (This includes all items of expenses other than depreciation, interest, and taxes.) The effective tax rate will be 50 per cent.
5. Plant and equipment will be depreciated at the rate of 33 1/3 per cent per year as per the written down value method. So the depreciation charges will be

	(Rs in million)
First year	2.00
Second year	1.33
Third year	0.89
Fourth year	0.59
Fifth year	0.40

Given the above details the post-tax, incremental cash flows relating to long-term funds are worked out in Exhibit 7.1. Some clarifications about this exhibit are in order. The initial investment, occurring at the end of year 0, is Rs 7 million. This represents the commitment of long-term funds to the project. (Note that the total outlay on the project is Rs 10 million. However, our focus is on flows relating to long-term funds.) The operating cash inflow, relating to long term funds, at the end of year 1 is Rs 3.07 million. This is defined as follows:

Profit after tax + Depreciation + Interest on (1-tax rate)
debentures

Rs 0.845 million + Rs 2 million + Rs 0.45 million (1-0.50)

The operating cash inflows for the subsequent years have been calculated similarly. The terminal cash flow relating to long-term funds is equal to :

Net salvage value of plant and equipment + Net recovery of working capital margin

It may be noted that when the project is terminated, its liquidation value will be equal to:

Net salvage value of plant and equipment + Net recovery of working capital

The first component belongs to the suppliers of long-term funds. The second component is applied to repay the current liabilities and recover the working capital margin.

EXHIBIT 7.1

Cash Flows for the New Project

(Rs in million)

		Years 0	1	2	3	4	5
A	Plant and equipment	(6.00)					
B	Working capital margin	(1.00)					
C	Revenues		8.00	8.00	8.00	8.00	8.00
D	Operating costs		3.50	3.50	3.50	3.50	3.50
E	Depreciation		2.00	1.333	0.889	0.593	0.395
F	Interest on short-term bank borrowings		0.36	0.36	0.36	0.36	0.36
G	Interest on debentures		0.45	0.45	0.45	0.45	0.45
H	Profit before tax		1.690	2.357	2.801	3.097	3.295
I	Tax		0.845	1.179	1.401	1.549	1.648
J	Profit after tax		0.845	1.178	1.400	1.548	1.647
K	Net salvage value of plant and equipment						2.00
L	Net recovery working capital margin						1.00
M	Initial investment $(A + B)$	(7.00)					
N	Operating cash inflows $(J + E + G\ (I - T))$		3.070	2.736	2.514	2.366	2.267
O	Terminal cash flow $(K + L)$						3.000
P	Net cash flow $(M + N + O)$	(7.00)	3.070	2.736	2.514	2.366	5.267

Illustration II

Puratan Enterprises is assessing the cash flow associated with the replacement of an old machine by a new machine. The old machine bought a few years ago has a book value of Rs 90,000 and it can be sold for Rs 90,000. It has a remaining life of five years after which its salvage value is expected to be nil. It is being depreciated annually at the rate of 20 per cent (written down value method).

The new machine costs Rs 4,00,000. It is expected to fetch Rs 2,50,000 after 5 years when it will no longer be required. It will be depreciated annually at the rate of 33 1/3 per cent (written down value method). The new machine is expected to bring a saving of Rs 1,00,000 in manufacturing costs. Investment in working capital as well as interest on short-term borrowings would remain unaffected. The tax rate applicable to the firm is 50 per cent.

Given the above information, the incremental post-tax cash flows associated with the replacement project are worked out in Exhibit 7.2. Three points may be noted while reading this exhibit.

1. The financing mix employed for meeting the net investment required for the new machine is not given. So the interest burden on long-term debt financing, if any, has not been shown separately as an item of expense and consequently its tax-adjusted value has not been added back. That is the operating cash inflow has been defined as:

   Profit before interest and taxes (1 – tax rate)

   It may be recalled that this is equivalent to:

   Profit after tax + interest (1 – tax rate)

2. In the case of a replacement project we must look at the difference between the old machine and the new machine at the time of replacement, during the operating life, and at the time of liquidation. This means that we have to ask the following questions: When the replacement takes place what is the net investment (the cost of new machine less the proceeds from the sale of the old machine)? During the operating life of the project what is the difference between the new machine and the old machine in terms of cash flows? Finally, at the time of liquidation what is the difference between the salvage value of the new machine and the old machine?[5]
3. The analysis is focussed on only those items which differ between the two alternatives, viz., 'continue with the existing machine' and 'replace the existing machine'. So items like revenues, interest on short-term borrowings, and so on which are identical for the two alternatives are ignored as they are irrelevant.

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[5] **To appreciate the rationale for this procedure, consider the following situation. A firm is currently using a machine which has a balance life of four years. If this machine is replaced with a new machine now it will fetch a salvage value of Rs 2 million. However, if it is used for four years its salvage value after four years will be Rs 1 million. The new machine costs Rs 5 million. It is expected to bring a saving of Rs 1 million per year in raw material, labour, power, and maintenance costs. After four years, this machine will fetch a salvage value of Rs 2.5 million. Given this information, the cash flows of the two alternatives (ignoring depreciation and taxes for the sake of simplicity) can be set up as follows:**

	Year 0	**Year 1**	**Year 2**	**Year 3**	**Year 4**
Old Machine					
Initial investment	**(2)**				
Operating cash inflows	**–**	**–**	**–**	**–**	**–**
Terminal cash flow	**–**	**–**	**–**	**–**	**1**
Net cash flow	**(2)**	**–**	**–**	**–**	**1**
New Machine					
Initial investment	**(5)**				
Operating cash inflows		**1**	**1**	**1**	**1**
Terminal cash flow					**2**
Net cash flow	**(5)**	**1**	**1**	**1**	**3**

Hence the incremental flows associated with the replacement project are as follows:

Year 0	**Year 1**	**Year 2**	**Year 3**	**Year 4**
(3)	**1**	**1**	**1**	**2**

Two things may be noted here. (i) The initial investment of Rs 2 million shown against the old machine represents an opportunity cost. This means that if the old machine is kept in use the firm foregoes an opportunity to realise Rs 2 million from its sale. (ii) As far as the operating cash inflows are concerned the only item which causes the difference between the two alternatives is the cost savings of 1 million associated with the new machine. Hence, this is shown against the new machine.

EXHIBIT 7.2

Cash Flows for the Replacement Project

(Rupees ('000))

	Years 0	1	2	3	4	5
A Net investment in machine	(310)					
B Savings in manufacturing costs		100	100	100	100	100
C Depreciation on old machine		18	14.4	11.5	9.2	7.4
D Depreciation on new machine		133.3	88.9	59.3	39.5	26.3
E Incremental depreciation on new machine (*C* – *D*)		115.3	74.5	47.8	30.3	18.9
F Incremental taxable profit (*B* – *E*)		(15.3)	25.5	52.2	69.7	71.1
G Incremental tax		(7.7)	12.8	26.1	34.9	35.6
H Incremental profit after tax		(7.7)	12.7	26.1	34.8	35.5
I Net incremental salvage value						250.0
J Initial investment (*A*)	(310)					
K Operating cash inflows (*H* + *E*)		107.6	87.2	73.9	65.1	54.5
L Terminal cash flow (*I*)						250.0
M Net cash flow (*J* + *K* + *L*)	(310)	107.6	87.2	73.9	65.1	304.5

Illustration III

India Pharma Limited is engaged in the manufacture of pharmaceuticals. The company was established in 1981 and has registered a steady growth in sales since then. Presently the company manufactures 16 products and its annual turnover is Rs 220 million. The company is considering the manufacture of a new antibiotic preparation, K-cin, for which the following information has been gathered.

1. K-cin is expected to have a product life of five years and thereafter it would be withdrawn from the market. The sales from this preparation are expected to be as follows:

Year	Sales (Rs in million)
1	10
2	15
3	20
4	15
5	10

2. The capital equipment required for manufacturing K-cin costs Rs 10 million. It will be financed by equity capital and debenture capital in equal proportions, in conformity with the target capital structure of the firm. The interest rate on debentures will be 15 per cent. The depreciation rate applicable to it is thirty three

and one third per cent (WDV method) for tax purposes. The expected salvage value after five years is Rs 4 million.

3. The working capital required for this project is expected to be 20 per cent of sales. One-half of it would be supported by spontaneous current liabilities (like trade credit, accruals, and so on); the other half would be financed by working capital borrowings from a commercial bank carrying an interest rate of 18 per cent per annum.
4. The accountant of the firm has provided the following cost estimates for K-cin:

   Raw material cost : 30 per cent of sales
   Variable labour cost : 20 per cent of sales
   Fixed annual operating and maintenance cost : Rs 1 million
   Overhead allocation (excluding depreciation, maintenance, and interest) : 10 per cent of sales

   While the project is charged an overhead allocation, it is not likely to have any effect on overhead expenses as such.
5. The manufacture of K-cin would also require some of the common facilities of the firm. The use of these facilities would call for reduction in the production of other pharmaceutical preparations of the firm. This would entail a reduction of Rs 1.5 million of contribution margin.
6. At the end of 5 years, the current assets (working capital) are expected to be liquidated at par value, barring an estimated loss of Rs 0.5 million on account of bad debts.
7. The tax rate applicable to the firm is 50 per cent.

Based on the above information, the cash flows for the project have been worked out in Exhibit 7.3. Two points about this exhibit are in order:

1. The loss of contribution (item *F*) is an opportunity cost.
2. Overhead expenses allocated to the project have been ignored as they do not represent incremental overhead expenses for the firm as a whole.

VIEWING A PROJECT FROM DIFFERENT POINTS OF VIEW

In the preceding discussion we looked at a project from the point of view of long-term funds and defined its cash flows accordingly. However, a project may be viewed from two other points of view as well: the equity point of view and the total funds point of view. To compare the alternative points of view—the equity point of view, the long-term funds point of view, and the total funds point of view—let us consider an example.

Magnum Technologies Limited is evaluating an electronics project for which the following information has been assembled:

1. The total outlay on the project is expected to be Rs 50 million. This consists of Rs 30 million of fixed assets and Rs 20 million of current assets.
2. The total outlay of Rs 50 million is proposed to be financed as follows: Rs 15 million of equity, Rs 20 million of term loans, Rs 10 million of bank finance for working capital, and Rs 5 million of trade credit.

EXHIBIT 7.3

Cash Flows for the K-cin Project

(Rs in million)

Years

		0	1	2	3	4	5
A	Capital investment	(10.0)					
B	Revenues		10.00	15.00	20.00	15.00	10.00
C	Raw material cost		3.00	4.50	6.00	4.50	3.00
D	Labour cost		2.00	3.00	4.00	3.00	2.00
E	Maintenance cost		0.50	0.50	0.50	0.50	0.50
F	Loss of contribution		1.50	1.50	1.50	1.50	1.50
G	Depreciation		3.33	2.22	1.48	0.99	0.66
H	Interest on short-term borrowings		0.18	0.27	0.36	0.27	0.18
I	Interest on debentures		0.75	0.75	0.75	0.75	0.75
J	Bad debt loss		–	–	–	–	0.50
K	Profit before tax		(1.26)	2.26	5.41	3.49	0.91
L	Tax		(0.63)	1.13	2.71	1.75	0.46
M	Profit after tax		(0.63)	1.13	2.71	1.74	0.45
N	Net salvage value of equipment		–	–	–	–	4.00
O	Initial investment (*A*)	(10.00)					
P	Operating cash inflow $\{M + G + I(1-t)\}$		3.08	3.73	4.57	3.11	1.49
Q	Terminal cash flow (*N*)						4.00
R	Net cash flow $(O + P + Q)$	(10.00)	3.08	3.73	4.57	3.11	5.49

3. The term loan is repayable in five equal annual instalments of Rs 4 million each. The first instalment will fall due at the end of the first year and the last instalment at the end of the fifth year. The levels of bank finance for working capital and trade credit will remain at Rs 10 million and Rs 5 million till they are paid back or retired at the end of five years.
4. The interest rates on the term loan and bank finance for working capital will be 15 per cent and 18 per cent respectively.
5. The expected revenues from the project will be Rs 60 million per year. The operating costs, excluding depreciation, will be Rs 42 million. The depreciation rate on the fixed assets will be 33 1/3 per cent as per the written down value method.
6. The net salvage value of fixed assets and current assets at the end of year 5 will be Rs 5 million and Rs 20 million respectively.
7. The tax rate applicable to the firm is 50 per cent.

Cash Flows Relating to Equity

The equity-related cash flow stream reflects the contributions made and benefits receivable by equity shareholders. It may be divided into three components as follows:

- Initial investment : Equity funds committed to the project
- Operating cash inflows : Profit after tax – Preference dividend + Depreciation + Other non-cash charges
- Liquidation and retirement cash flows (terminal cash flows) : Net salvage value of fixed assets
  +
  Net salvage value of current assets
  –
  Repayment of term loans
  –
  Redemption of preference capital
  –
  Repayment of working capital advances
  –
  Retirement of trade credit and other dues.

While the first two components, namely,'initial investment' and 'operating cash inflows' are fairly self-explanatory, the third term, namely, 'liquidation and retirement cash flows' requires a little explanation. It represents the net cash flows accruing to equity shareholders as a result of liquidation of various assets in the project and retirement/redemption of all other sources of financing. Remember that equity shareholders have a residual interest in the project and hence what is left after meeting the claims of all other suppliers of finance belongs to equity shareholders.

Exhibit 7.4 works out the cash flows from the equity point of view for the electronics project of Magnum Technologies Limited.

Cash Flows Relating to Long-term Funds

As discussed earlier in this chapter, the cash flow stream relating to long-term funds consists of three components as follows:

Initial investment : Long-term funds invested in the project. This is equal to: fixed assets + working capital margin.
Operating cash inflow : Profit after tax
+
Depreciation
+
Other non-cash charges
+
Interest on long-term borrowings (1 – tax rate)
Terminal cash flow : Net salvage value of fixed assets
+
Net recovery of working capital margin.

EXHIBIT 7.4

Net Cash Flows Relating to Equity

(Rs in million)

	Years 0	1	2	3	4	5
A Equity funds	(15.0)					
B Revenues		60.00	60.00	60.00	60.00	60.00
C Operating costs		42.00	42.00	42.00	42.00	42.00
D Depreciation		10.00	6.67	4.44	2.96	1.98
E Interest on working capital advance		1.80	1.80	1.80	1.80	1.80
F Interest on term loan		3.00	2.40	1.80	1.20	0.60
G Profit before tax		3.20	7.13	9.96	12.04	13.62
H Tax		1.60	3.57	4.98	6.02	6.81
I Profit after tax		1.60	3.56	4.98	6.02	6.81
J Preference dividend		–	–	–	–	–
K Net salvage value of fixed assets		–	–	–	–	5.00
L Net salvage value of current assets		–	–	–	–	20.00
M Repayment of term-loans		4.00	4.00	4.00	4.00	4.00
N Redemption of preference capital		–	–	–	–	–
O Repayment of short-term bank borrowings		–	–	–	–	10.00
P Retirement of trade creditors		–	–	–	–	5.00
Q Initial investment (*A*)	(15.00)					
R Operating cash inflows ($I - J + D$)		11.60	10.23	9.42	8.98	8.79
S Liquidation and retirement cash flows ($K + L - M - N - O - P$)		(4.00)	(4.00)	(4.00)	(4.00)	(4.00)
T Net cash flow ($Q + R + S$)	(15.00)	7.60	6.23	5.42	4.98	11.79

Exhibit 7.5 shows the cash flows relating to long-term funds for the electronics project of Magnum Technologies Limited.

Cash Flows Relating to Total Funds

The cash flow stream relating to total funds consists of three components as follows:

Initial investment : All the funds committed to the project. This is simply the total outlay on the project consisting of fixed assets as well as current assets.

Operating cash inflow : Profit after tax
+
Depreciation
+
Other non-cash charges
+
Interest on long-term borrowings (1 – tax rate)
+
Interest on short-term borrowings (1 – tax rate)

Terminal cash flow : Net salvage value of fixed assets
+
Net salvage value of current assets

EXHIBIT 7.5

Net Cash Flows Relating to Long-term Funds

(Rs in million)

	Years					
	0	1	2	3	4	5
A Fixed assets	(30.0)					
B Working capital margin	(5.0)					
C Revenues		60.00	60.00	60.00	60.00	60.00
D Operating costs		42.00	42.00	42.00	42.00	42.00
E Depreciation		10.00	6.67	4.44	2.96	1.98
F Interest on working capital advance		1.80	1.80	1.80	1.80	1.80
G Interest on term loan		3.00	2.40	1.80	1.20	0.60
H Profit before tax		3.20	7.13	9.96	12.04	13.62
I Tax		1.60	3.57	4.98	6.02	6.81
J . Profit after tax		1.60	3.56	4.98	6.02	6.81
K Net salvage value of fixed assets						5.00
L Net recovery of working capital margin						5.00
M Initial investment ($A + B$)	(35.0)					
N Operating cash inflow ($J + E + G(I - T)$)		13.10	11.43	10.32	9.58	9.09
O Terminal cash flow ($K + L$)						10.00
P Net cash flow ($M + N + O$)	(35.0)	13.10	11.43	10.32	9.58	19.09

Exhibit 7.6 shows the net cash flows from the point of view of total funds for the electronics project of Magnum Technologies Limited.

HOW FINANCIAL INSTITUTIONS AND THE PLANNING COMMISSION DEFINE CASH FLOWS

Financial Institutions

In evaluating project proposals submitted to them, financial institutions (all-India financial institutions as well as state-level financial institutions) define project cash flows as follows:

Cash outflows

Fixed assets
+ } Cost of project
Current assets – Working capital margin
– Interest during construction period
+
Increase in current assets with
increase in the level of production

EXHIBIT 7.6

Net Cash Flows Relating to Total Funds

(Rs in million)

	Years					
	0	1	2	3	4	5
A Total funds	(50.00)					
B Revenues		60.00	60.00	60.00	60.00	60.00
C Operating costs		42.00	42.00	42.00	42.00	42.00
D Depreciation		10.00	6.67	4.44	2.96	1.98
E Interest on working capital advance		1.80	1.80	1.80	1.80	1.80
F Interest on term loan		3.00	2.40	1.80	1.20	0.60
G Profit before tax		3.20	7.13	9.96	12.04	13.62
H Tax		1.60	3.57	4.98	6.02	6.81
I Profit after tax		1.60	3.56	4.98	6.02	6.81
J Net salvage value of fixed assets						5.00
K Net salvage value of current assets						20.00
L Initial investment (*A*)	(50.00)					
M Operating cash inflow ($G + D + F(1 - t) + E(1 - t)$)		14.00	12.33	11.22	11.98	9.99
N Terminal cash flow ($J + K$)						25.00
O Net cash flow ($L + M + N$)	(50.00)	14.00	12.33	11.23	11.98	34.99

Cash inflows

Operating inflow : Earnings before depreciation interest and taxes

Terminal inflow : Residual value of fixed assets (equal to 5 per cent of the initial cost in case of depreciable assets)

+

Realisable value of current assets (put as equal to their par value)

From the above, it is clear that financial institutions look at a project from the point of view of total funds. It is instructive to compare the cash flow stream defined by the financial institutions with the cash flow stream relating to total funds defined by us earlier in this chapter. The comparison is shown below.

	Cash flow stream defined by financial institutions	*Cash flow stream relating to total funds specified earlier*
Initial investment	Outlay on fixed assets plus current assets	Outlay on fixed assets plus current assets

Operating cash inflow	Earnings before depreciation, interest, and taxes	Profit after tax + Depreciation + Interest on all borrowings (1– tax rate) + Interest on term loans (1 – tax rate)
Terminal cash inflow	Residual value of fixed assets + Realisable value of current assets	Net salvage value of fixed assets + Net salvage value of current assets

Comparing the cash flow streams given above, we find that:

(a) The initial investment is defined identically in both the cases.

(b) The operating cash inflow is defined in pre-tax terms by financial institutions but in post-tax terms by us.

(c) The terminal cash inflow is defined in both the cases in a similar manner.[6]

Planning Commission

As per the *Manual for Preparation of Feasibility Reports* developed by the Planning Commission, the following rules should be observed in defining costs and returns (cash flows in our terminology).

1. Interest during construction should not be allowed for in the year-wise capital expenditure figures since it is implicitly taken into account by the discounting procedure. If replacement expenditure is likely to be incurred during the life of the project it should be allowed for in the year in which it will occur.
2. Returns should be defined on a gross basis as operating revenues minus operating costs. Depreciation and financial charges on capital expenditures covered by the capital cost figures should not be deducted in defining returns. *They are allowed for implicitly in the discounting procedure.*
3. Capital cost estimates generally do not allow for funds required for working capital purposes, which are assumed to be borrowed, but only for the margin on working capital. In this case the operating cost estimates must include interest payments on funds borrowed for working capital.
4. In some cases involving the use of fixed-interest term loans for capital expenditure, an internal rate of return on own funds (equity) may need to be presented. In such cases the initial capital cost figures should cover only the expenditures out of equity capital. Repayment of terms loans and interest due on them should be allowed for in the subsequent years as and when they are expected to arise.

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[6] However, the procedures of estimation seem to be different. Financial institutions typically define the residual value of fixed assets as equal to 5 per cent of the initial cost of depreciable assets and 100 per cent of the initial cost of non-depreciable assets. Clearly, no explicit effort is made to estimate the likely salvage value at the end of the project life and the tax liability thereon as part of an exercise to establish the net salvage value, as suggested earlier in this chapter. Likewise, the realisable value of current assets is typically put equal to its par value. This procedure appears simple and acceptable and obviates the need to consider the effect of tax factor.

5. Costs and returns should be calculated over the entire life of the project or over 25 years whichever is less. The returns should allow for a salvage value of assets at the end of the period.

Based on the above description, the following observations may be made:

1. A project may be viewed from the point of view of equity capital or long-term funds.
2. Cost and return (benefit) streams have been defined consistently with the point of view adopted. Further, they are defined in pre-tax terms.
3. A fairly long planning horizon is envisaged. This perhaps reflects the fact that the projects considered by the Planning Commission, in general, have a long economic life.

BIASES IN CASH FLOW ESTIMATION

As cash flows have to be forecast far into the future, errors in estimation are bound to occur. Yet, given the critical importance of cash flow forecasts in project evaluation, adequate care should be taken to guard against certain biases which may lead to over-statement or under-statement of true project profitability.

Overstatement of Profitability

Knowledgeable observers of capital budgeting believe that profitability is often overstated because the initial investment is under-estimated and the operating cash flow exaggerated. The principal reasons for such optimistic bias appear to be as follows:

- *Intentional overstatement* In a bid to present their projects in a favourable light, project sponsors may intentionally over-estimate the benefits and under-estimate the costs. Given the uncertainties characterising the future, project sponsors enjoy some latitude in twisting the figures the way they want.
- *Lack of experience* Inadequate experience on the part of project sponsors generally leads to over-optimistic estimates. Experience often induces conservatism that checks over-optimistic tendencies. Inexperience, on the other hand, may lead to wishful thinking.
- *Myopic euphoria* Individuals responsible for preparing forecasts may become too involved and lose their sense of proportion. The lack of objectivity in this case is neither intentional nor due to inexperience. It may simply be the effect of 'mass psychology' as each person's favourable opinion may be reinforced and magnified by others in the group. Referred to as the "risky shift" or "group polarization effect" in social psychology, this phenomenon is widely supported by empirical studies.[7]
- *Capital rationing* Companies typically operate under capital rationing, which may be externally determined or internally imposed. An awareness of such a constraint induces project sponsors to exaggerate the benefits of projects proposed by them. After all every sponsor is keen that his proposal finds a place in the limited capital budget when there is competition among various claimants.

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[7] D.G. Myres and H. Lamm, "The Group Polarization Phenomenon", *Psychological Bulletin* (July 1976), pp 602-612.

Under-statement of Profitability

In the foregoing discussion, we noted the problem of optimistic bias that may lead to an over-statement of project cash flows and profitability. There can be an opposite kind of bias relating to the terminal benefit which may depress a project's true profitability. To understand this bias let us look at how the terminal cash flow is estimated in practice. Typically it is defined as :

Net salvage value of fixed assets	+	Net recovery of working capital margin

Generally, the net salvage value of fixed assets is put equal to 5 per cent of the original cost and the net recovery of working capital margin is set equal to its original book value (under the assumption that current assets do not depreciate).

The above approach almost invariably leads to under-estimation of the terminal benefit of the project, due to the following reasons:

Salvage values are under-estimated To put the net salvage value of fixed assets equal to just 5 per cent (which may more or less correspond to the book value after 8 to 10 years) of the original cost is to ignore the fact that in real life situations fixed assets, even after 8 to 10 years of use, generally command a substantial market value. This is because (a) the rate of physical wear and tear is usually much less than the rate of depreciation for tax or accounting purposes and (b) the secular rate of inflation in India has been around 8 per cent.

Intangible benefits are ignored The terminal benefit from a project cannot be equated with just the salvage values of tangible assets left in the project. Apart from investment in tangible assets for which salvage values can be estimated more easily (taking into account the factors mentioned above), major projects are designed to establish a market position, hone research and engineering capability, develop a distribution network, and build brand loyalty. To assume that these benefits are worthless beyond an arbitrarily chosen time horizon is to overlook important business realities. These benefits should not be ignored just because it is difficult to quantify them.

The value of future options is overlooked More often than not, a project has a strategic payoff in the form of new investment opportunities that may possibly open up if the project is undertaken. To illustrate, consider the case of a firm which is evaluating a proposal to set up a project for manufacturing scooters. The long term goal of the firm is to be a market leader in the field of two-wheelers, scooters as well as motorcycles. However, the firm considers entry into the motorcycles market to be infeasible currently as it lacks technical expertise or market image to challenge well-entrenched manufacturers in the field. Thus, the proposal to manufacture motorcycles hinges on the expertise developed and success achieved in the field of scooters. Put differently, it means that the project for manufacturing scooters has a potential payoff in terms of entry into a new field which may generate a large benefit. So, in assessing the scooter project the value of future options generated by it must be taken into account. Since analytical models for doing this are not well developed, judgemental estimation, though subjective in nature, may be done.

SUMMARY

- Cash outflows, not expenses in accounting terms, are the relevant measure of financial costs; likewise, cash inflows, not revenues as determined by accounting conventions, reflect financial benefits.
- For developing the project cash flows, the following principles must be kept in mind: incremental principle, long-term funds principle, exclusion of financing costs principle, and post-tax principle.
- To ascertain a project's incremental cash flows, one has to look at what happens to the cash flows of the firm with the project and without the project, and not before the project and after the project as is sometimes done.
- It is generally recommended that a project may be evaluated from the point of view of long-term funds because the principal focus of project evaluation is normally on the profitability of long-term funds.
- When cash flows relating to long-term funds are being defined, financing costs of long-term funds should be excluded as the weighted average cost of capital used for evaluating the cash flows takes into account the cost of long-term funds.
- Tax payments, like other payments, must be properly deducted in deriving the cash flows. Put differently, cash flows must be defined in post-tax terms.
- The cash flow stream associated with a project may be divided into three basic components: (i) an initial investment, (ii) operating cash inflows, and (iii) a terminal cash inflow.
- The initial investment represents the relevant cash outflow when the project is set up. For a new project (as distinct from a replacement project), the initial investment is equal to:

  Cost of capital assets
  +
  Installation costs
  +
  Working capital margin
  +
  Preliminary and pre-operative expenses
  –
  Tax shield, if any, on capital assets
- The operating cash inflows are the relevant cash inflows arising from the operation of the project during its economic life. The operating cash inflow for a new project for any given year is defined as follows:

  Profit after tax
  +
  Depreciation
  +
  Other non-cash charges
  +
  Interest on long-term debt (1 – tax rate).

- The terminal cash inflow is the relevant cash flow occurring at the end of the project life on account of project liquidation. The terminal cash inflow for a new project is defined as follows:

  Post-tax proceeds from the sale of capital assets

  +

  Net recovery of working capital margin.

- The time horizon for project cash flow analysis is usually the minimum of the following: the physical life of the plant, the technological life of the plant, the product-market life of the plant, and the investment planning horizon of the firm.
- Besides the long-term funds point of view, which has been emphasised above, a project may be viewed from two other points of view: the equity point of view and the total funds point of view. Obviously, the project cash flow definition will vary with the point of view adopted.
- Financial institutions look at projects from the point of view of total funds. Further, they define cash flows in pre-tax terms. The Planning Commission also follows more or less the same approach.
- Certain biases tend to characterise cash flow estimates. The initial investment tends to be under-estimated and the operating cash inflows are likely to be over-estimated. As against this optimistic bias, there is likely to be a pessimistic bias as far as the estimation of the terminal cash inflow is concerned.

QUESTIONS

1. Discuss the guidelines that must be borne in mind while estimating the incremental cash flow of a project.
2. Explain the 'exclusion of financing costs' principle.
3. Define the following for a new project as well as a replacement project: (a) initial investment, (b) operating cash inflows, and (c) terminal cash flow.
4. What factors influence the time horizon for cash flow analysis?
5. Define the cash flow from the point of view of equity funds and total funds.
6. How do financial institutions define cash outflows and inflows for a project?
7. Describe the rules applicable to the measurement of costs and returns (cash flows) as given in the *Manual for Preparation of Feasibility Reports* developed by the Planning Commission.
8. Discuss the possible sources of optimistic bias as well as pessimistic bias in cash flow estimation.

PROBLEMS

1. Bionics Limited is considering investment in a project on which the following information is available:

   (a) The total outlay on the project will be Rs 25 million. This consists of Rs 16 million on plant and equipment and Rs 9 million on gross working capital. The entire outlay will be incurred at the end of year 0.

(b) The project will be financed with Rs 7 million of equity, Rs 11million of long-term debt (in the form of debentures), Rs 5 million of working capital advance, Rs 2 million of trade credit. The interest rate on debentures and working capital advance will be 15 per cent and 17 per cent respectively.

(c) The life of the project is expected to be 6 years. At the end of 6 years, plant and equipment would fetch a net salvage value of Rs 6 million and working capital (current assets) would be liquidated at its book value.

(d) The project will increase the revenue of the firm by Rs 20 million per year. The increase in operating expenses on account of the project will be Rs 9 million per year. (This includes all items of expenses other than depreciation, interest, and taxes.) The tax rate for the firm will be 50 per cent.

(e) The plant and machinery will be depreciated at the rate of 33 1/3 per cent as per the written down value method for tax purposes.

Determine the cash flows for the above project from the point of view of long-term funds.

2. Sulabha Corporation is considering a proposal to replace one of its machines. The following information is available:

(a) The existing machine was bought five years ago for Rs 1 million. It was depreciated at 20 per cent per annum (WDV method) for the first two years. Thereafter, the depreciation rate was 10 per cent per annum. This rate will continue in future. The machine has a remaining life of five years after which its net salvage value is expected to be Rs 0.2 million. Its present net salvage value is Rs 0.6 million.

(b) The new machine costs Rs 2 million and its depreciation rate will be 33 1/3 per cent. After 5 years it is expected to fetch Rs 1 million. The installation of this machine will increase the annual revenue by Rs 100,000 and decrease the annual total cost (excluding depreciation and interest on long-term borrowings) by Rs 50,000.

The tax rate for the firm is 50 per cent. Determine the cash flows associated with the replacement proposal.

3. Supreme Industries is evaluating a project for which the following information has been assembled:

(a) The total outlay of the project is expected to Rs 450 million. This consists of Rs 250 million of fixed assets and Rs 200 million of current assets.

(b) The proposed scheme of financing is as follows: Rs 100 million of equity, Rs 200 million of term loans, Rs 100 million of working capital advance, and Rs 50 million of trade credit.

(c) The term loan is repayable in 10 equal semi-annual instalments of Rs 20 million each. The first instalment will fall due after 18 months. The interest rate on the term loan will be 15 per cent.

(d) The levels of working capital advance and trade credit will remain at Rs 100 million and Rs 50 million respectively till they are paid back or retired at the end of 6 years. The working capital advance will carry an interest rate of 18 per cent.

(e) The expected revenues for the project will be Rs 500 million per year. The operating costs (excluding depreciation and interest) are expected to be Rs 320 million per year. The depreciation rate on the fixed assets will be 33 1/3 per cent as per the written down value method.

(f) The net salvage value of fixed assets and current assets, at the end of year 6 (the project life is expected to be 6 years) will be Rs 80 million and Rs 200 million respectively.

(g) Tax rate applicable to the firm is 50 per cent.

Define the cash flows from the point of view of (i) equity funds, (ii) long-term funds, and (iii) total funds.

8

Time Value of Money

Money has time value. A rupee today is more valuable than a rupee a year hence. Why? There are several reasons:

- Individuals, in general, prefer current consumption to future consumption.
- Capital can be employed productively to generate positive returns. An investment of one rupee today would grow to $(1 + r)$ a year hence (r is the rate of return earned on the investment).
- In an inflationary period, a rupee today represents a greater real purchasing power than a rupee a year hence.

Many financial problems involve cash flows occurring at different points of time. For evaluating such cash flows an explicit consideration of time value of money is required. This chapter discusses the methods for dealing with time value of money. It is divided into four sections as follows:

- Future value of a single amount
- Future value of an annuity
- Present value of a single amount
- Present value of an annuity

FUTURE VALUE OF A SINGLE AMOUNT

Suppose you have Rs 1,000 today and you deposit it with a financial institution, which pays 10 per cent interest compounded annually, for a period of 3 years. The deposit would grow as follows:

			Rs
First year	:	Principal at the beginning Interest for the year	1,000
		(Rs 1,000 × 0.10)	100
		Principal at the end	1,100
Second year	:	Principal at the beginning	1,100
		Interest for the year (Rs 1,100 × 0.10)	110
		Principal at the end	1,210

			Rs
Third year	:	Principal at the beginning	1,210
		Interest for the year (Rs 1,210 × 0.10)	121
		Principal at the end	1,331

Formula

The general formula for the future value of a single amount is:

$$FV = PV\,(1+k)^n \tag{8.1}$$

where FV = future value n years hence
PV = amount today (present value)
k = interest rate per year
n = number of years for which compounding is done

The growth of future value is shown in Exhibit 8.1.

EXHIBIT 8.1

Future Value of a Single Amount

Year	Amount in the beginning	Interest for the year	Amount at the end
1	PV	PVk	$FV_1 = PV\,(1+k)$
2	$PV\,(1+k)$	$PV\,(1+k)\,k$	$FV_2 = PV\,(1+k)^2$
3	$PV\,(1+k)^2$	$PV\,(1+k)^2\,k$	$FV_3 = PV\,(1+k)^3$
⋮		⋮	⋮
$n-1$	$PV\,(1+k)^{n-2}$	$PV\,(1+k)^{n-2}\,k$	$FV_{n-1} = PV\,(1+k)^{n-1}$
n	$PV\,(1+k)^{n-1}$	$PV\,(1+k)^{n-1}\,k$	$FV_n = PV\,(1+k)^n$

Equation (8.1) is a basic equation in compounding analysis. The factor $(1+k)^n$ is referred to as the compounding factor or the future value interest factor ($FVIF_{k,n}$). It is very tedious to calculate $(1+k)^n$ unless you have a calculator. To reduce the tedium, published tables are available showing the value of $(1+k)^n$ for various combinations of k and n. One such table is given in Appendix A at the end of this book. Exhibit 8.2 shows some values of $(1+k)^n$.

EXHIBIT 8.2

Value of $FVIF_{k,n}$ for Various Combinations of k and n

n/k	6%	8%	10%	12%	14%
2	1.124	1.166	1.210	1.254	1.300
4	1.262	1.360	1.464	1.574	1.689
6	1.419	1.587	1.772	1.974	2.195
8	1.594	1.851	2.144	2.476	1.853
10	1.791	2.159	2.594	3.106	3.707
12	2.012	2.518	3.138	3.896	4.817

Example If you deposit Rs 1,000 today in a bank which pays 10 per cent interest compounded annually, how much will the deposit grow to after 8 years and 12 years?

The future value 8 years hence will be:

$$\text{Rs } 1{,}000(1.10)^8 = \text{Rs } 1{,}000\ (2.144) = \text{Rs } 2{,}144$$

The future value 12 years hence will be:

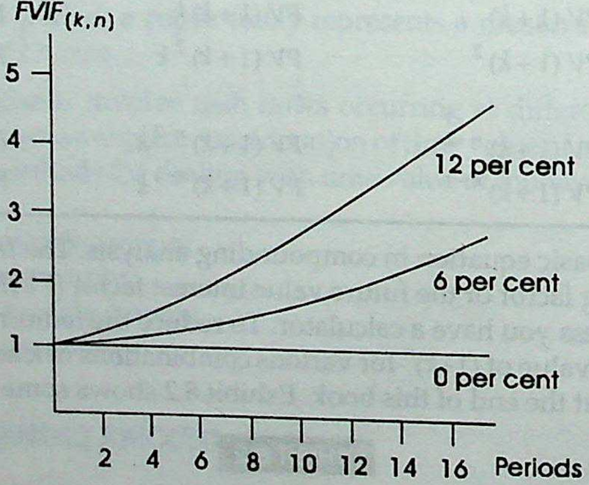
$$\text{Rs } 1{,}000(1.10)^{12} = \text{Rs } 1{,}000(3.138) = \text{Rs } 3{,}138$$

Graphic View

Exhibit 8.3 shows graphically how one rupee would grow over time for different interest rates. Naturally higher the interest rate, faster the growth rate. We have plotted the growth curves for three interest rates: 0 per cent, 6 per cent, and 12 per cent. Growth curves can be readily plotted for other interest rates.

EXHIBIT 8.3

Graphic View of Compounding



Doubling Period

Investors commonly ask the question: How long would it take to double the amount at a given rate of interest? To answer this question we may look at the future value interest factor table. Looking at Exhibit 8.1 we find that when the interest rate is 12 per cent it takes about 6 years to double the amount, when the interest rate is 6 per cent it takes about 12 years to double the amount, so on and so forth. Is there a rule of thumb which dispenses with the use of the present value interest factor table? Yes, there is one and it is called the *rule of 72*. According to this rule of thumb the doubling period is obtained by dividing 72 by the interest rate. For example, if the interest rate is 8 per cent, the doubling period is 9 years (72/8). Likewise, if the interest rate is 4 per cent the doubling period is about 18 years (72/4). Though somewhat crude, it is a handy and useful rule of thumb.

If you are inclined to do a slightly more involved calculation, a more accurate rule of thumb is the *rule of 69*[1]. According to this rule of thumb, the doubling period is equal to:

$$0.35 + \frac{69}{\text{Interest rate}}$$

As an illustration of this rule of thumb, the doubling period is calculated for two interest rates, 10 per cent and 15 per cent:

Interest rate	**Doubling period**
10 per cent	$0.35 + \frac{69}{10} = 7.25$ years
15 per cent	$0.35 + \frac{69}{15} = 4.95$ years

Finding the Growth Rate

To calculate the compound rate of growth of some series, say the sales series or the profit series, over a period of time, we may employ the future value interest factor table. The method may be demonstrated with the help of the following sales data for Alpha Limited.

Year	**1981**	**1982**	**1983**	**1984**	**1985**	**1987**
Sales (Rs in million)	50	57	68	79	86	99

What was the compound rate of growth in the sales of Alpha for the period 1981-87, a six-year period? This question may be answered in two steps:

Step 1 Find the ratio of sales of 1987 to 1981. This is simply : 99/50 = 1.98.

Step 2 Consult the $FVIF_{k,n}$ table and look at the row for 6 years till you find a value which is closest to 1.98 and then read the interest rate corresponding to that value. In this case, the value closest to 1.98 is 1.974 and the interest rate corresponding to this is 12 per cent. Hence the compound rate of growth is almost 12 per cent.

Shorter Compounding Period

So far we assumed that compounding is done annually. Now we consider the case where compounding is done more frequently. Suppose you deposit Rs 10,000 with a finance company which advertises that it pays 12 per cent interest semi-annually—this means that interest is paid every six months. Your deposit (if interest is not withdrawn) grows as follows:

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[1] For details about the *rule of 69* and its comparison with the *rule of 72*, see J.P. Gould and R.L. Weil, "The Rule of 69", *Journal of Business*, July 1974.

First six months	:	Principal at the beginning	= Rs 1,000.00
		Interest for six months (Rs 1,000 × .12/2)	= 60.00
		Principal at the end	= Rs 1,060.00
Second six months	:	Principal at the beginning	= Rs 1,060.00
		Interest for six months (Rs 1,060.00 × .12/2)	= 63.60
		Principal at the end	= Rs 1,123.60

Note that if compounding is done annually the principal at the end of one year would be Rs 1,100.00 (1.12) = Rs.1,120.00. The difference of Rs 3.60 (between Rs 1,123.60 under semi-annual compounding and Rs 1,120.00 under annual compounding) represents interest on interest for the second 6 months.

The general formula for the future value of a single amount when compounding is done more frequently than annually is:

$$FV_n = PV\,(1+k)^{m \times n} \tag{8.2}$$

where FV_n = future value after n years
PV = amount today (present value)
k = nominal annual rate of interest
m = number of times compounding is done during a year
n = number of years for which compounding is done.

Example How much does a deposit of Rs 5,000 grow to at the end of 6 years, if the nominal rate of interest is 12 per cent and the frequency is 4 times a year? The amount after 6 years will be:

$$\text{Rs } 5000\left(1+\frac{0.12}{4}\right)^{4\times 6} = \text{Rs } 5{,}000\,(1.03)^{24}$$

$$= \text{Rs } 5{,}000 \times 2.0328 = \text{Rs } 10{,}164$$

Effective Versus Nominal Rate

We have seen above that Rs 1,000 grows to Rs 1,123.60 at the end of a year if the nominal rate of interest is 12 per cent and compounding is done semi-annually. This means that Rs 1,000 grows at the rate of 12.36 per cent per annum. The figure of 12.36 per cent is called the effective rate of interest—the rate of interest under annual compounding which produces the same result as that produced by an interest rate of 12 per cent under semi-annual compounding.

The general relationship between the effective rate of interest and the nominal rate of interest is as follows:

$$r = \left(1+\frac{k}{m}\right)^{m} - 1 \tag{8.3}$$

where r = effective rate of interest
k = nominal rate of interest
m = frequency of compounding per year

Example A bank offers 8 per cent nominal rate of interest with quarterly compounding. What is the effective rate of interest?

The effective rate of interest is:

$$\left(1+\frac{0.08}{4}\right)^4 - 1 = 0.0824 = 8.24 \text{ per cent}$$

Exhibit 8.4 shows the relationship between the nominal and effective rates of interest for different compounding periods. In general, the effect of increasing the frequency of compounding is not as dramatic as some would believe it to be—the additional gains dwindle as the frequency of compounding increases.

FUTURE VALUE OF AN ANNUITY

An annuity is a series of periodic cash flows (payments or receipts) of equal amounts. The premium payments of a life insurance policy, for example, are an annuity. When the cash flows occur at the end of each period the annuity is called a regular annuity or a deferred annuity. When the cash flows occur at the beginning of each period the annuity is called an annuity due. Our discussion here will focus on a regular annuity—the formulae of course can be applied, with some modification, to an annuity due.

EXHIBIT 8.4

Nominal and Effective Rates of Interest

	Effective Rate			
Nominal rate (%)	*Annual* *compounding* (%)	*Semi-annual* *compounding* (%)	*Quarterly* *compounding* (%)	*Monthly* *compounding* (%)
8	8.00	8.16	8.24	8.30
12	12.00	12.36	12.55	12.68

Suppose you deposit Rs 1,000 annually in a bank for 5 years and your deposits earn a compound interest rate of 10 per cent. What will be the value of this series of deposits (an annuity) at the end of 5 years? Assuming that each deposit occurs at the end of the year, the future value of this annuity will be:

$$\text{Rs } 1{,}000(1.10)^4 + \text{Rs } 1{,}000(1.10)^3 + \text{Rs } .1{,}000(1.10)^2$$
$$+ \text{Rs } 1{,}000(1.10) + \text{Rs } 1{,}000 = \text{Rs } 1{,}000(1.4641) + \text{Rs } 1{,}000(1.331)$$
$$+ \text{Rs } 1{,}000(1.21) + \text{Rs } 1{,}000(1.10) + \text{Rs } 1{,}000 = \text{Rs } 6{,}105.$$

The time line for this annuity is shown in Exhibit 8.5.

Formula

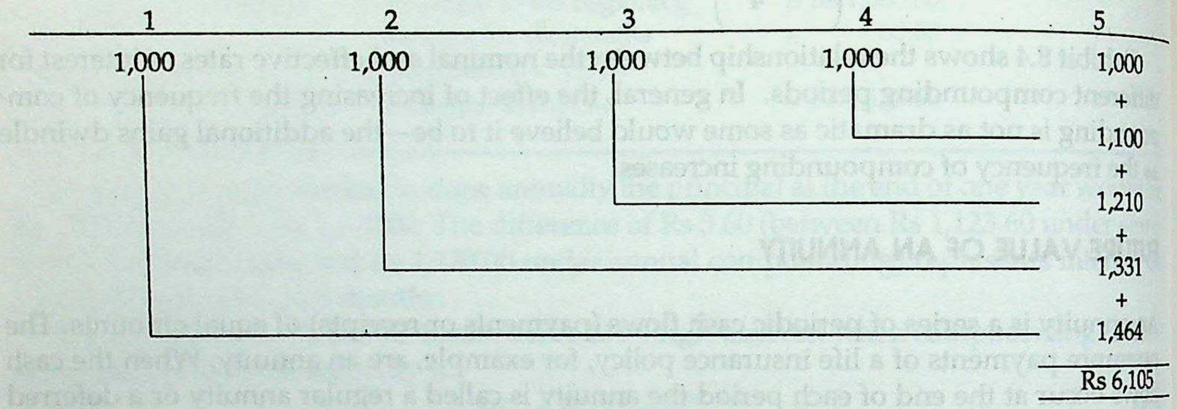
In general terms the future value of an annuity is given by the following formula:

$$FVA_n = A(1+k)^{n-1} + A(1+k)^{n-2} + \ldots + A$$

$$= A\left[\frac{(1+k)^n - 1}{k}\right] \qquad (8.4)$$

EXHIBIT 8.5

Time Line for an Annuity



where FVA_n = future value of an annuity which has a duration of n periods
A = constant periodic flow
k = interest rate per period
n = duration of the annuity

The term $\frac{(1+k)^n - 1}{k}$ is referred to as the future value interest factor for an annuity ($FVIFA_{k,n}$). The value of this factor for several combinations of k and n is given in Exhibit 8.6. A more detailed table is given in Appendix A at the end of the book.

EXHIBIT 8.6

Value of $FVIFA_{k,n}$ for Various Combinations of k and n

n/k	6%	8%	10%	12%	14%
2	2.060	2.080	2.100	2.120	2.140
4	4.375	4.507	4.641	4.779	4.921
6	6.975	7.336	7.716	8.115	8.536
8	9.897	10.636	11.436	12.299	13.232
10	13.181	14.487	15.937	17.548	19.337
12	16.869	18.977	21.384	21.133	27.270

Example Four equal annual payments of Rs 2,000 are made into a deposit account that pays 8 per cent interest per year. What is the future value of this annuity at the end of 4 years?

The future value of this annuity is:

$$\text{Rs } 2{,}000\ (FVIFA_{8\%,4}) = \text{Rs } 2{,}000\ (4.507)$$
$$= \text{Rs } 9{,}014$$

Sinking Fund Factor

Equation (8.4) shows the relationship between FVA_n, A, k, and n. Juggling it a bit, we get:

$$A = FVA_n \left[\frac{k}{(1+k)^n - 1} \right] \tag{8.5}$$

$\left[\frac{k}{(1+k)^n - 1} \right]$ in Eq. (8.5), the inverse of $FVIFA_{k,n}$ is called the sinking fund factor.

Equation (8.5) helps in answering the question: How much should be deposited periodically to accumulate a certain sum at the end of a given period? The periodic deposit is simply A and it is obtained by dividing FVA_n, by $FVIFA_{k,n}$

Example How much should you save annually to accumulate Rs 20,000 by the end of 10 years, if the saving earns an interest of 12 per cent?

$$A = \text{Rs } 20{,}000 \times \frac{1}{FVIFA_{12\%,10}}$$

$$A = \text{Rs } 20{,}000 \times \frac{1}{17.548} = \text{Rs } 1{,}140$$

Finding the Interest Rate

Given the relationship between FVA_n, A, k, and n, the interest rate (k) can be easily figured out if the values of the other three—FVA_n, A, and n,—are known.

Example A finance company advertises that it will pay a lumpsum of Rs 8,000 at the end of 6 years to investors who deposit annually Rs 1,000 for 6 years. What interest rate is implicit in this offer?

The interest rate may be calculated in two steps:

1. Find the $FVIFA_{k,6}$ for this contract as follows:

   $\text{Rs } 8{,}000 = \text{Rs } 1{,}000 \times FVIFA_{k,6}$

   $FVIFA_{k,6} = \frac{\text{Rs } 8{,}000}{\text{Rs } 1{,}000} = 8.000$

2. Look at the $FVIFA_{k,n}$ table and read the row corresponding to 6 years until you find a value close to 8.000. Doing so, you find that

   $FVIFA_{12\%,6}$ is 8.115

So you conclude that the interest rate is slightly below 12 per cent.

PRESENT VALUE OF A SINGLE AMOUNT

Suppose someone promises to give you Rs 1,000 three years hence. What is the present value of this amount if the interest is 10 per cent? The present value can be calculated by discounting Rs 1,000 to the present point of time, as follows:

Value three years hence = Rs 1,000

Value two years hence = $\text{Rs } 1{,}000 \left(\frac{1}{1.10} \right)$

$$\text{Value one year hence} = \text{Rs } 1{,}000 \left(\frac{1}{1.10}\right)\left(\frac{1}{1.10}\right)$$

$$\text{Value now (present value)} = \text{Rs } 1{,}000 \left(\frac{1}{1.10}\right)\left(\frac{1}{1.10}\right)\left(\frac{1}{1.10}\right)$$

Formula

The process of discounting, used for calculating the present value, is simply the inverse of compounding. The present value formula can be readily obtained by manipulating the compounding formula:

$$FV_n = PV\,(1+k)^n \tag{8.1}$$

Dividing both the sides of Equation (8.1) by $(1+k)^n$, we get

$$PV = FV_n \left[\frac{1}{1+k}\right]^n \tag{8.6}$$

The factor $\left[\frac{1}{1+k}\right]^n$ in Eq. (8.6) is called the discounting factor or the present value interest factor ($PVIF_{k,\,n}$). Exhibit 8.7 gives the value of $PVIF_{k,\,n}$ for several combinations of k and n. A more detailed table of $PVIF_{k,\,n}$ is given in Appendix A at the end of this book.

Example Find the present value of Rs 1,000 receivable 6 years hence if the rate of discount is 10 per cent.

The present value is:

Rs 1,000 × $PVIF_{10\%,\,6}$ = Rs 1,000 (0.5645) = Rs 564.50

Example Find the present value of Rs 1,000 receivable 20 years hence if the discount rate is 8 per cent. Since Exhibit 8.7 does not have the value of $PVIF_{8\%,\,20}$ we obtain the answer as follows:

$$\text{Rs } 1{,}000\left[\frac{1}{1.08}\right]^{20} = \text{Rs } 1{,}000\left[\frac{1}{1.08}\right]^{10}\left[\frac{1}{1.08}\right]^{10}$$

$$= \text{Rs } 1{,}000\,(PVIF_{8\%,\,10})\,(PVIF_{8\%,\,10})$$

$$= \text{Rs } 1{,}000\,(0.463)\,(0.463) = \text{Rs } 214.$$

EXHIBIT 8.7

Value of $PVIF_{k,\,n}$ for Various Combinations of k and n

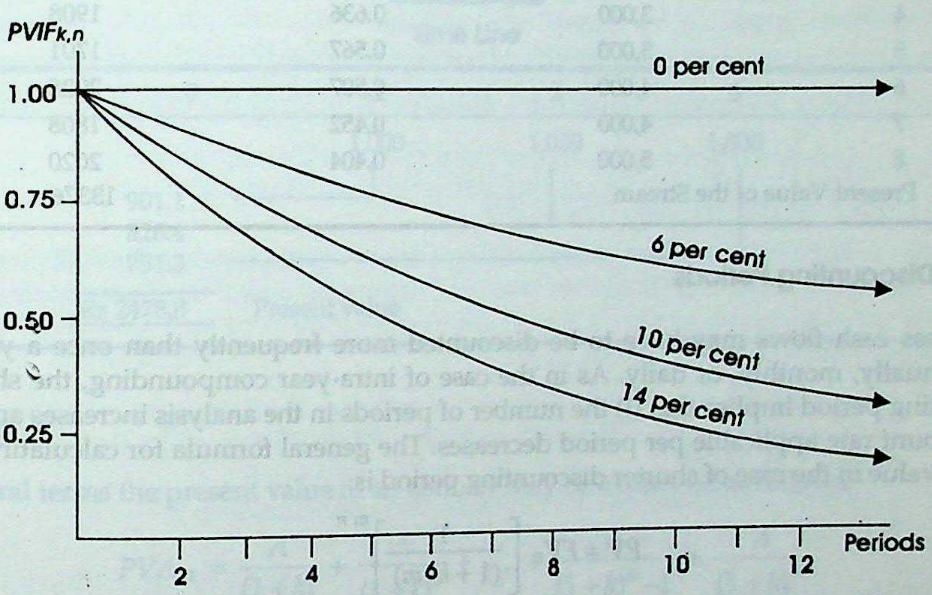
n/k	6%	8%	10%	12%	14%
2	0.890	0.857	0.826	0.797	0.770
4	0.792	0.735	0.683	0.636	0.592
6	0.705	0.630	0.565	0.507	0.456
8	0.626	0.540	0.467	0.404	0.351
10	0.558	0.463	0.386	0.322	0.270
12	0.497	0.397	0.319	0.257	0.208

Graphic View of Discounting

Exhibit 8.8 shows graphically how the present value interest factor varies in response to changes in interest rate and time. The present value interest factor declines as the interest rate rises and as the length of time increases.

EXHIBIT 8.8

Graphic View of Discounting



Present Value of an Uneven Series

In financial analysis we often come across uneven cash flow streams. For example, the cash flow stream associated with a capital project is typically uneven. Likewise, the dividend stream associated with an equity share is usually uneven and perhaps growing.

The present value of a cash flow stream, uneven or even, may be calculated with the help of the following forumula.

$$PV_n = \frac{A_1}{(1+k)} + \frac{A_2}{(1+k)^2} + \ldots + \frac{A_n}{(1+k)^n} = \sum_{t=1}^{n} \frac{A_t}{(1+k)^t} \tag{8.7}$$

where PV_n = present value of a cash flow stream
A = cash flow occurring at the end of year t
k = discount rate
n = duration of the cash flow stream

Exhibit 8.9 shows the calculation of the present value of an uneven cash flow stream, using a discount rate of 12 per cent.

EXHIBIT 8.9

Present Value of an Uneven Cash Flow Stream

Year	Cash flow Rs	$PVIF_{12\%, n}$	Present value
1	1,000	0.893	893
2	2,000	0.799	1594
3	2,000	0.712	1424
4	3,000	0.636	1908
5	3,000	0.567	1701
6	4,000	0.507	2028
7	4,000	0.452	1808
8	5,000	0.404	2020
Present Value of the Stream			13376

Shorter Discounting Periods

Sometimes cash flows may have to be discounted more frequently than once a year—semi-annually, monthly, or daily. As in the case of intra-year compounding, the shorter discounting period implies that (i) the number of periods in the analysis increases and (ii) the discount rate applicable per period decreases. The general formula for calculating the present value in the case of shorter discounting period is:

$$PV = FV_n \left[\frac{1}{(1 + k/m)} \right]^{mn} \tag{8.8}$$

where PV = present value
FV_n = cash flow after a year
m = number of times per year discounting is done
k = annual discount rate

To illustrate, consider a cash flow of Rs 11,000 to be received at the end of four years. The present value of the cash flow when the discount rate is 12 per cent (k = 12 per cent) and discounting is done quarterly (m = 4) is determined as follows:

$$\begin{aligned} PV &= \text{Rs } 10{,}000 \times PVIF_{k/m,\ m \times n} \\ &= \text{Rs } 10{,}000 \times PVIF_{3\%,\ 16} \\ &= \text{Rs } 10{,}000 \times 0.623 = \text{Rs } 6{,}230 \end{aligned}$$

PRESENT VALUE OF AN ANNUITY

Suppose you expect to receive Rs 1,000 annually for 3 years, each receipt occurring at the end of the year. What is the present value of the stream of benefits if the discount rate is 10 per cent? The present value of this annuity is simply the sum of the present values of all the inflows of this annuity.

$$\text{Rs } 1{,}000\left(\frac{1}{1.10}\right)+\text{Rs } 1{,}000\left(\frac{1}{1.10}\right)^2+\text{Rs } 1{,}000\left(\frac{1}{1.10}\right)^3$$

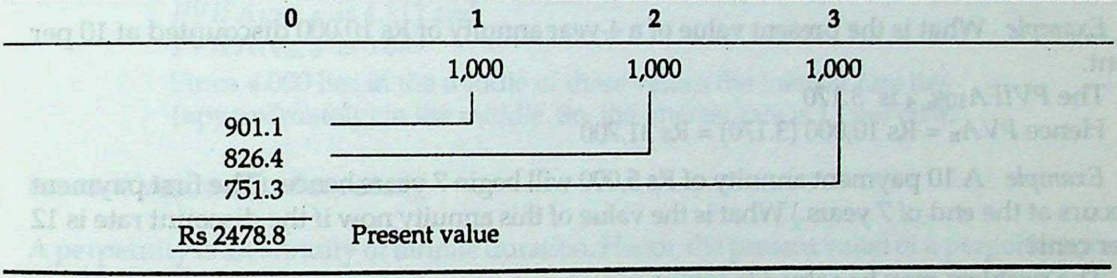
$$= \text{Rs } 1{,}000 \times 0.9091 + \text{Rs } 1{,}000 \times 0.8264 + \text{Rs } 1{,}000 \times 0.7513$$

$$= \text{Rs } 2{,}478.8$$

The time line for this problem is shown in Exhibit 8.10.

EXHIBIT 8.10

Time Line



Formula

In general terms the present value of an annuity may be expressed as follows:

$$PVA_n = \frac{A}{(1+k)} + \frac{A}{(1+k)^2} + \ldots + \frac{A}{(1+k)^n - 1} + \frac{A}{(1+k)^n} \tag{8.9}$$

$$= A\left[\frac{1}{(1+k)} + \frac{1}{(1+k)^2} + \ldots + \frac{1}{(1+k)^n - 1} + \frac{1}{(1+k)^n}\right]$$

$$= A\left[\frac{(1+k)^n - 1}{k(1+k)^n}\right]$$

where PVA_n = present value of annuity which has a duration of n periods

A = constant periodic flow

k = discount rate

$\left[\frac{(1+k)^n - 1}{k(1+k)^n}\right]$ is referred to as the present value interest factor for an annuity. It is, as can be seen clearly, simply equal to the product of the future value interest factor for an annuity ($PVIFA_{k,n}$) and the present value interest factor ($PVIFA_{k,n}$). Exhibit 8.11 shows the value of $PVIFA_{k,n}$ for several combinations of k and n. A more detailed table of $PVIFA_{k,n}$ values is found in Appendix A at the end of this book.

EXHIBIT 8.11

Value of $PVIFA_{k,n}$ for Different Combinations of k and n

n/k	6%	8%	10%	12%	14%
2	1.833	1.783	1.737	1.690	1.647
4	3.465	3.312	3.170	3.037	2.914
6	4.917	4.623	4.355	4.111	3.889
8	6.210	5.747	5.335	4.968	4.639
10	7.360	6.710	6.145	5.650	5.216
12	8.384	7.536	6.814	6.194	5.660

Example What is the present value of a 4-year annuity of Rs 10,000 discounted at 10 per cent.

The $PVIFA_{10\%,\,4}$ is 3.170

Hence PVA_n = Rs 10,000 (3.170) = Rs 31,700

Example A 10 payment annuity of Rs 5,000 will begin 7 years hence. (The first payment occurs at the end of 7 years.) What is the value of this annuity now if the discount rate is 12 per cent?

The problem may be solved in two steps.

Step 1 Determine the value of this annuity a year before the first payment begins, i.e., 6 years from now. This is equal to Rs 5,000 ($PVIFA_{12\%,\,10}$) = Rs 5,000 (5.650) = Rs 28,250

Step 2 Compute the present value of the amount obtained in Step 1. Rs 28,250 ($PVIF_{12\%,\,6}$) = Rs 28,250 (0.507) = Rs 14,323

Capital Recovery Factor

Equation (8.9) shows the relationship between PVA_n, A, k, and n. Manipulating it a bit, we get

$$A = PVA_n\left[\frac{k(1+k)^n}{(1+k)^n - 1}\right] \tag{8.10}$$

$\left[\frac{k(1+k)^n}{(1+k)^n - 1}\right]$ in Eq. (8.10), the inverse of $PVIFA_{k,n}$, is called the capital recovery factor.

Example Your father deposits Rs 100,000 on retirement in a bank which pays 10 per cent annual interest. How much can he withdraw annually for a period of 10 years?

$$A = \text{Rs } 100{,}000 \times \frac{1}{PVIFA_{10\%,\,10}}$$

$$= \text{Rs } 100{,}000 \times \frac{1}{6.145}$$

$$= \text{Rs } 16{,}273$$

Finding the Interest Rate

Suppose someone offers you the following financial contract. If you deposit Rs 10,000 with him, he promises to pay Rs 2,500 annually for 6 years. What interest rate do you earn on this deposit? The interest rate may be calculated in two steps.

Step 1 Find the $PVIFA_{k,6}$ for this contract by dividing Rs 10,000 by Rs 2,500

$$PVIFA_{k,6} = \frac{\text{Rs } 10{,}000}{\text{Rs } 2{,}500} = 4.000$$

Step 2 Look at the *PVIFA* table and read the row corresponding to 6 years until you find a value close to 4.000 . Doing so, you find that
$PVIFA_{12\%,6}$ is 4.111 and
$PVIFA_{14\%,6}$ is 3.889
Since 4.000 lies in the middle of these values the interest rate lies (approximately) in the middle. So, the interest rate is 13 per cent.

Present Value of a Perpetuity

A perpetuity is an annuity of infinite duration. Hence, the present value of a perpetuity may be expressed as follows:

$$P = A \times PVIFA_{k,\infty} \tag{8.11}$$

where
PV_∞ = present value of a perpetuity
A = constant annual payment
$PVIFA_{k,\infty}$ = present value interest factor for a perpetuity (an annuity of infinite duration)

What is the value of $PVIFA_{k,\infty}$? It is simply:

$$\sum_{t=1}^{\infty} \frac{1}{(1+k)^t} = \frac{1}{k} \tag{8.12}$$

Put in words, it means that the present value interest factor of a perpetuity is simply 1 divided by the interest rate expressed in decimal form. Hence, the present value of a perpetuity is simply equal to the constant annual payment divided by the interest rate. For example, the present value of a perpetuity of Rs 10,000 if the interest rate is 10 per cent is equal to: Rs 10,000/0.10 = Rs 1,00,000. Intuitively this is quite convincing because an initial sum of Rs 1,00,000 would, if invested at a rate of interest of 10 per cent, provide a constant annual income of Rs 10,000 for ever without any impairment of the capital value.

SUMMARY

- Money has time value. A rupee today is more valuable than a rupee a year hence.
- The general formula for the future value of a single amount is:

$$FV_n = PV(1+k)^n$$

- According to the *rule of* 72 the doubling period is obtained by dividing 72 by the interest rate.
- When compounding is done more frequently than annually the effective rate of interest is greater than the nominal rate of interest.
- An annuity is a series of periodic cash flows of equal amounts. The general formula for the future value of an annuity is:

$$FVA_n = A\left[\frac{(1+k)^n - 1}{k}\right]$$

By juggling this formula, we can obtain the formula for the sinking fund factor as well.

- The process of discounting, used for calculating the present value, is simply the inverse of compounding. The present value of a single amount is given by the formula:

$$PV = FV_n\left[\frac{1}{(1+k)}\right]^n$$

- The present value of a cash flow stream—uneven or even—may be calculated with the help of the following formula:

$$PV_n = \sum_{t=1}^{n} \frac{A_t}{(1+k)^t}$$

- The present value of an annuity is given by the following formula:

$$PVA_n = A\left[\frac{(1+k)^n - 1}{k(1+k)^n}\right]$$

By juggling this formula, we can derive the formula for the capital recovery factor.

- The present value of a perpetuity (a perpetuity is an annuity of infinite duration) is simply 1 divided by interest rate.

QUESTIONS

1. Why does money have time value?
2. State the general formula for the future value of a single cash flow.
3. Explain the *rule of* 72.
4. Explain the *rule of* 69. How does it compare with the *rule of* 72?
5. What is the relationship between the effective rate of interest and nominal rate of interest?
6. What is an annuity?
7. State the formula for the future value of an annuity.
8. What is a sinking fund factor? Illustrate with an example.
9. State the general formula for calculating the present value of a single cash flow.
10. What is the general formula for calculating the present value of a cash flow series?
11. State the formula for the present value of an annuity.
12. What is a capital recovery factor? Illustrate it with an example.

13. A firm's earnings grew from Rs 1.00 per share to Rs 3.00 per share over a period of 10 years. The total growth was 200 per cent, but the annual compound growth rate was less than 20 per cent. Why?

PROBLEMS

1. Calculate the value 5 years hence of a deposit of Rs 1,000 made today if the interest rate is (i) 8 per cent (ii) 10 per cent (iii) 12 per cent and (iv) 15 per cent.
2. If you deposit Rs 5,000 today at 12 per cent rate of interest in how many years (roughly) will the amount grow to Rs 160,000? Work the problem using the *rule of 72*—do not use tables.
3. A finance compnay offers to give Rs 8,000 after 12 years in return for Rs 1,000 deposited today. Using the *rule of 69*, figure out the approximate interest offered.
4. You can save Rs 2,000 a year for 5 years, and Rs 3,000 a year for 10 years thereafter. What will these savings cumulate to at the end of 15 years, if the rate of interest is 10 per cent?
5. Mr.Vinay plans to send his son for higher studies abroad after 10 years. He expects the cost of these studies to be Rs 100,000. How much should he save annually to have a sum of Rs 100,000 at the end of 10 years, if the interest rate is 12 per cent.
6. A finance company advertises that it will pay a lumpsum of Rs 100, 000 at the end of 6 years to investors who deposit Rs 1,000 annually . What interest rate is implied in this offer?
7. Someone promises to give you Rs 5,000 after 10 years in exchange of Rs 1,000 today. What interest rate is implied in the offer?
8. Find the present value of Rs 10,000 receivable after 8 years if the rate of discount is (i) 10 per cent (ii) 12 per cent and (iii) 15 per cent.
9. What is the present value of a 5 year annuity of Rs 2,000 at 10 per cent?
10. At the time of his retirement, Mr. Jingo is given a choice between two alternatives (i) an annual pension of Rs 10,000 as long as he lives , and (ii) a lumpsum amount of Rs 50,000. If Mr. Jingo expects to live for 15 years and the interest rate is 15 per cent, which option appears more attractive?
11. Mr. X deposits Rs 100,000 in a bank, which pays 10 per cent interest. How much can he withdraw annually for a period of 30 years. Assume that at the end of 30 years the amount deposited will whittle down to zero.
12. What is the present value of an income stream which provides Rs 1,000 at the end of year one, Rs 2,500 at the end of year two, and Rs 5,000 during each of the years 3 through 10, if the discount rate is 12 per cent.
13. What is the present value of an income stream which provides Rs 2,000 a year for the first five years, and Rs 3,000 a year forever thereafter, if the discount rate is 10 per cent?
14. What amount must be deposited today in order to earn an annual income of Rs 5,000 beginning from the end of 15 years from now? The deposit earns 10 per cent per year.
15. Suppose someone offers you the following financial contract. If you deposit Rs 20,000 with him, he promises to pay Rs 4,000 annually for 10 years. What interest rate would you earn on this deposit?
16. What is the present value of the following cash flow streams?

End of year	Stream A	Stream B	Stream C
1	100	1,000	500
2	200	900	500
3	300	800	500
4	400	700	500
5	500	600	500
6	600	500	500
7	700	400	500
8	800	300	500
9	900	200	500
10	1,000	100	500

The discount rate is 10 per cent.

17. Suppose you deposit Rs 10,000 with an investment company which pays 16 per cent interest with quarterly compounding. How much will the deposit grow to in 5 years?
18. How much would a deposit of Rs 5,000 at the end of 5 years be, if the nominal rate is 12 per cent and if the compounding is done quarterly?
19. What is the difference between the effective rate of interest and nominal rate of interest in the following cases:

    Case A: Nominal rate of interest is 12 per cent and the frequency of compounding is twice a year.

    Case B : Nominal rate of interest is 12 per cent and the frequency of compounding is six times a year.

    Case C : Nominal rate of interest is 24 per cent and the frequency of compounding is four times a year.

    Case D : Nominal rate of interest is 24 per cent and the frequency of compounding is twelve times a year.
20. If the interest rate is 12 per cent how much investment is required now to yield an income of Rs 12,000 per year from the beginning of the 10th year and continuing thereafter forever?
21. You have a choice between Rs 5,000 now and Rs 20,000 after 10 years. Which would you choose? What does your preference indicate?
22. Mr. Raghu deposits Rs 10,000 in a bank now. The interest rate is 10 per cent and compounding is done semi-annually. What will the deposit grow to after 10 years? If the inflation rate is 8 per cent per year, what will be the value of the deposit after 10 years in terms of the current rupee?
23. How much should be deposited at the beginning of each year for 10 years in order to provide a sum of Rs 50,000 at the end of 10 years?
24. A person requires Rs 20,000 at the beginning of each year from 2005 to 2009. How much should he deposit at the end of each year from 1995 to 2000? The interest rate is 12 per cent.
25. What is the present value of Rs 2,000 receivable annually for 30 years? The first receipt occurs after 10 years and the discount rate is 10 per cent.
26. After five years Mr. Ramesh will receive a pension of Rs 600 per month for 15 years. How much can Mr. Ramesh borrow now at 12 per cent interest so that the borrowed amount and interest can be paid with 30 per cent of the pension amount?
27. Mr. Prakash buys a scooter with a bank loan of Rs 6000. An instalment of Rs 300 is payable to the bank for each of 24 months towards repayment of loan with interest. What interest rate does the bank charge?

28. South India Corporation has to retire Rs 1 crore of debentures each at the end of 8, 9 and 10 years from now. How much should the firm deposit in a sinking fund account annually for 5 years in order to meet the debenture retirement need? The net interest rate earned is 8 per cent.
29. Mr. Longman receives a provident fund amount of Rs 100,000. He deposits it in a bank which pays 10 per cent interest. If he withdraws Rs 20,000 annually, how long can he do so?

APPENDIX 8A

DERIVATIONS OF ANNUITY FORMULAE

The following formulae were presented in Chapter 8:

Future value of an annuity: $A\left[\dfrac{(1+k)^n-1}{k}\right]$

Present value of an annuity: $A\left[\dfrac{(1+k)^n-1}{k(1+k)^n}\right]$

Present value of perpetuity: $\dfrac{A}{k}$

The derivations of these formulae are discussed below:

FUTURE VALUE OF AN ANNUITY

The future value of an annuity is:

$$FVA_n = A(1+k)^{n-1} + A(1+k)^{n-2} + \ldots + A(1+k) + A \tag{8A.1}$$

Multiplying both the sides of Eq. (8A.1) by $(1+k)$ gives

$$FVA_n\ (1+k) = A(1+k)^n + A(1+k)^{n-1} + \ldots\ A(1+k)^2 + A(1+k) \tag{8A.2}$$

Subtracting Eq. (8A.1) from Eq. (8A.2) yields:

$$FVA_n\ k = A\left[(1+k)^n - 1\right] \tag{8A.3}$$

Dividing both the sides of Eq. (8A.3) by k yields:

$$FVA_n = A\left[\frac{(1+k)^n-1}{k}\right] \tag{8A.4}$$

PRESENT VALUE OF AN ANNUITY

The present value of an annuity is:

$$PVA_n = A(1+k)^{-1} + A(1+k)^{-2} + \ldots + A(1+k)^{-n} \tag{8A.5}$$

Multiplying both the sides of Eq. (8A.5) by (1 + *k*) gives:

$$PVA_n(1+k) = A + A(1+k)^{-1} + \ldots A(1+k)^{-n+1} \tag{8A.6}$$

Subtracting Eq. (8A.5) from Eq. (8A.6) yields:

$$PVA_a \;\; k = A\left[1-(1+k)^{-n}\right] = A\left[\frac{(1+k)^n - 1}{(1+k)^n}\right] \tag{8A.7}$$

Dividing both the sides of Eq. (8A.7) by *k* results in:

$$PVA_n = A\left[\frac{(1+k)^n - 1}{k(1+k)^n}\right] \tag{8A.8}$$

PRESENT VALUE OF A PERPETUITY

A perpetuity is an annuity of an infinite duration. Hence, the present value of a perpetuity is expressed as:

$$PVA_\infty = A(1+k)^{-1} + A(1+k)^{-2} + \ldots + A(1+k)^{-\infty+1} + A(1+k)^{-\infty} \tag{8A.9}$$

Multiplying both the sides of Eq. (8A.9) by (1+ *k*) gives:

$$PVA_\infty(1+k) = A + A(1+k)^{-1} + \ldots + A(1+k)^{-\infty+1} \tag{8A.10}$$

Subtracting Eq. (8A.9) from Eq. (8A.10) yields:

$$PVA_\infty \; k = A\left[1-(1+k)^{-\infty}\right] \tag{8A.11}$$

As $(1+k)^{\infty} \to 0$, Eq. (8A.11) becomes:

$$PVA_\infty k = A \tag{8A.12}$$

This means:

$$PVA_\infty = \frac{A}{k} \tag{8A.13}$$

Equation (8A.13) implies that the present value of perpetuity of Re 1 is simply:

$$\frac{1}{k}$$

APPENDIX 8B

CONTINUOUS COMPOUNDING AND DISCOUNTING

In Chapter 8, we assumed that compounding or discounting takes place at specific intervals (annually, semi-annually, quarterly, and so forth) and cash flows occur at discrete points of time. In this appendix we explore the implications of continuous compounding and discounting and continuous cash flows.

FUTURE VALUE OF A PRESENT SUM

In Chapter 8, the following relationship was established for a case where compounding occurred m times a year.

$$r = \left(1 + \frac{k}{m}\right)^{m} - 1 \tag{8B.1}$$

where r = effective rate of interest
k = nominal rate of interest
m = frequency with which compounding is done in a year

Equation (8B.1) may be expressed as

$$r = \left[\left(1 + \frac{1}{m/k}\right)^{m/k}\right]^{k} - 1 \tag{8B.2}$$

Putting $x = m/k$ in Eq. (8B.2), we get

$$r = \left[\left(1 + \frac{1}{x}\right)^{x}\right]^{k} - 1 \tag{8B.3}$$

In continuous compounding $m \rightarrow \infty$. This means $x \rightarrow \infty$ in Eq. (8B.3). Now,

$$\lim \left(1 + \frac{1}{x}\right)^{x} = e = 2.71828 \ldots x \rightarrow \infty \tag{8B.4}$$

So from Eq. (8B.3), we get

$$r = e^{k} - 1 \tag{8B.5}$$

This leads to

$$(1+r) = e^{k} \tag{8B.6}$$

Thus, the equation for future value, when continuous compounding is done, is as follows:

$$FV_n = PV \times e^{kn} \tag{8B.7}$$

To illustrate, the future value of an annuity of Rs 50,000 for a period of 5 years when the interest rate is 8 per cent and continuous compounding is done is equal to:

$$\begin{aligned} FV_5 &= \text{Rs } 50{,}000\ (2.71828)^{.08 \times 5} \\ &= \text{Rs } 50{,}000\ (1.49182) \\ &= \text{Rs } 74{,}591 \end{aligned}$$

It may be of interest to note that the same deposit (Rs 50,000) when compounded annually would grow in 5 years to a future value of Rs 73,450—the higher future value under continuous compounding is attributable to the increase in the frequency of compounding.

PRESENT VALUE OF A FUTURE SUM

Employing the above reasoning the present value of a future sum, when continuous discounting is done, is given by the formula given below:

$$PV = FV_n \times e^{-kn} \tag{8B.8}$$

where PV = present value of future sum
FV_n = future sum at the end of n years
k = nominal discount rate

To illustrate, the present value of a future sum of Rs 50,000 receivable after 7 years, when discounting is done at 12 per cent on a continuous basis, is equal to:

$$\begin{aligned} PV &= \text{Rs } 50{,}000 \times 2.71828^{-.12 \times 7} \\ &= \text{Rs } 50{,}000 \times .431711 \\ &= \text{Rs } 21{,}585.55 \end{aligned}$$

If the same future sum (Rs 50,000) is discounted at 12 per cent on an annual basis, its present value will be Rs 22,600—the lower present value under continuous discounting is due to the increase in the frequency of discounting.

FUTURE VALUE OF AN ANNUITY

The future value of an annuity when compounding is done annually is equal to:

$$FVA_n = \left[\frac{(1+k)^n - 1}{k}\right] \qquad \text{(8B}$$

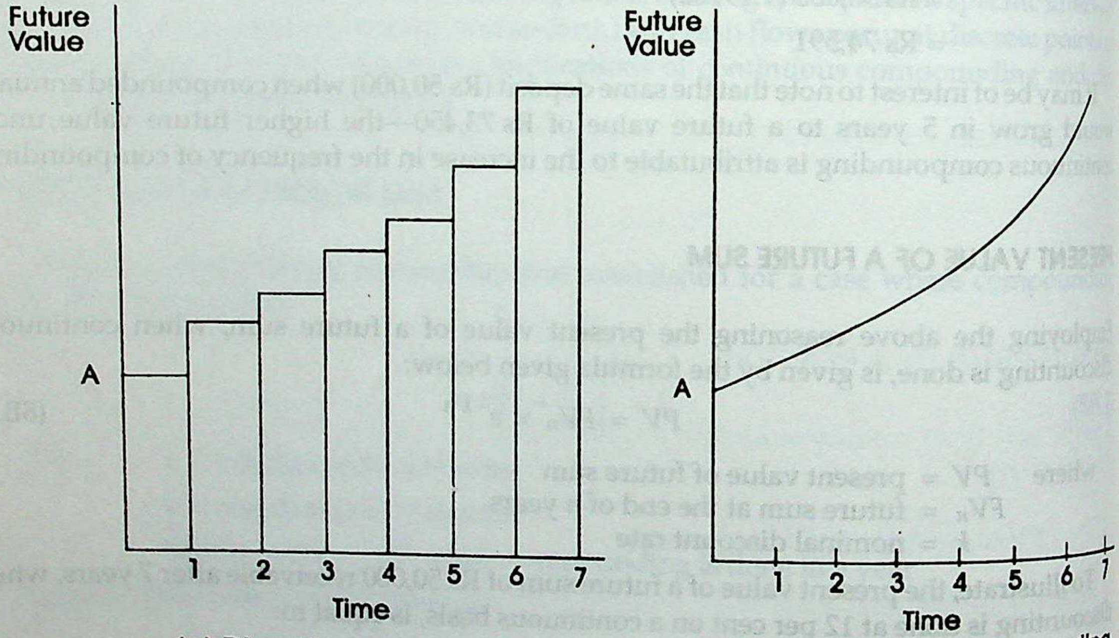
where FVA_n = future value of annuity

A = constant annual cash flow
k = interest rate
n = period of annuity

This formula is based on the assumption that cash flows occur in discrete amounts at the end of each year. Hence, the future value of an annuity, as given by this formula, corresponds to the area under the step-wise function shown in Exhibit 8B.1(a).

EXHIBIT 8B.1

Future Value of an Annuity Using Discrete Compounding and Continuous Compounding



(a) Discrete compounding (b) Continuous compounding

What happens in the case of continuous compounding? Here it is assumed that cash flows occur at a continuous rate from the beginning to the end and the future value of the annuity would correspond to the area under the continuous curve as shown in Exhibit 8B.1(b). Since each point on this curve is evaluated as

$$A_n = A\,e^{kn},$$

the area under the curve shown in Exhibit 8B.1(b) is equal to

$$FVA_n = \int_{N=0}^{n} A\ e^{kn}\ dN \tag{8B.10}$$

$$= A\left[\frac{e^{kn}}{k}\right]_0^n = A\left[\frac{e^{kn}}{k} - \frac{e^0}{k}\right] = A\left[\frac{e^{kn}-1}{k}\right] \tag{8B.11}$$

To illustrate, the future value of an annuity of Rs 50,000 for a period of 5 years when the interest rate is 8 per cent and continuous compounding is done is equal to

$$FVA_5 = \text{Rs } 50{,}000 \; \frac{e^{.08 \times 5} - 1}{.08} = \text{Rs } 50{,}000 \; \frac{1.49182 - 1}{.08}$$

$$= \text{Rs } 50{,}000 \, (6.14775) = \text{Rs } 307{,}387.5$$

In comparison, under annual compounding the future value of the above annuity will be

$$FVA_5 = \text{Rs } 50{,}000 \left[\frac{(1+k)^n - 1}{k} \right]$$

$$= \text{Rs } 50{,}000 \left[\frac{1.4693 - 1}{.08} \right] = \text{Rs } 293{,}312.5$$

PRESENT VALUE OF AN ANNUITY

The present value of an annuity when discounting is done annually is equal to:

$$PVA_n = A \left[\frac{1 - \dfrac{1}{(1+k)^n}}{k} \right] \tag{8B.12}$$

where PVA_n = present value of annuity
A = constant annual cash flow
k = interest rate
n = period of annuity

Under continuous discounting, it is assumed that the cash flows occur continuously throughout the period rather than as discrete amounts at the end of each year. Hence, the present value of an annuity, in the case of continuous discounting, is equal to:

$$PVA_n = \int_{N=0}^{n} A \, e^{-kn} \, d\,N = A \left[\frac{1 - e^{-kn}}{k} \right] \tag{8B.13}$$

For example, the present value of an annuity of Rs 50,000 per year for 7 years at a discount rate is 12 per cent under continuous discounting is equal to:

$$PVA_n = \text{Rs } 50{,}000 \left[\frac{1 - e^{-.12 \times 7}}{.12} \right]$$

$$= \text{Rs } 50{,}000 \left[\frac{1 - .431711}{.12} \right]$$

$$= \text{Rs } 2{,}36{,}787$$

By comparison, the present value of the above annuity under annual discounting is equal to:

$$PVA_n = \frac{\text{Rs } 50{,}000 \left[1 - \frac{1}{(1.12)^7}\right]}{0.12} = \text{Rs } 2{,}28{,}200$$

It may be noted that the lower value under annual discounting is because each cash flow is assumed to occur at the end of its respective period and not evenly throughout the period as in continuous discounting.

APPENDIX 8C

FORMULAE FOR GROWING OR DECLINING STREAMS

In Chapter 8 we discussed the formula for an annuity which represents a stream of constant periodic cash flow extending over a certain duration. In many situations, however, the stream of cash flows (payments or receipts) instead of remaining constant, as in the case of an annuity, grows or declines over time. In this appendix we will develop formulae for two types of growth (or decline), arithmetic growth (or decline) and compound growth (or decline).

ARITHMETIC GROWTH (DECLINE)

Arithmetic growth implies that the cash stream increases by a constant rupee amount each period. Exhibit 8C.1(a) for example, shows a cash stream which is growing at a rate of Rs 100 per period. Likewise, Exhibit 8C.1(b) shows a cash stream which is declining at a rate of Rs 100 per period. Arithmetic growth (decline) is also referred to as linear growth (decline) because the cash stream figures, when plotted against time on a graph, fall on a straight line.

To evaluate such a stream it may be split into two components: (a) the annuity component and (b) the growth (or decline) component. For example, the cash stream shown in Exhibit 8C.1(a) has an annuity component of Rs 500 per year for 5 years and a growth component of Rs 100 per year. Likewise, the cash stream shown in Exhibit 8C.1(b) has an annuity component of Rs 500 per year for 5 years and a decline component of Rs 100 per year.

The present value of a linearly growing or declining cash flow stream is simply the present value of the annuity component plus the present value of the growth component or minus the present value of the decline component, as the case may be.

Since the decline component is nothing but the negative of the growth component, we may express the present value of a linearly growing (declining) cash flow stream as follows:

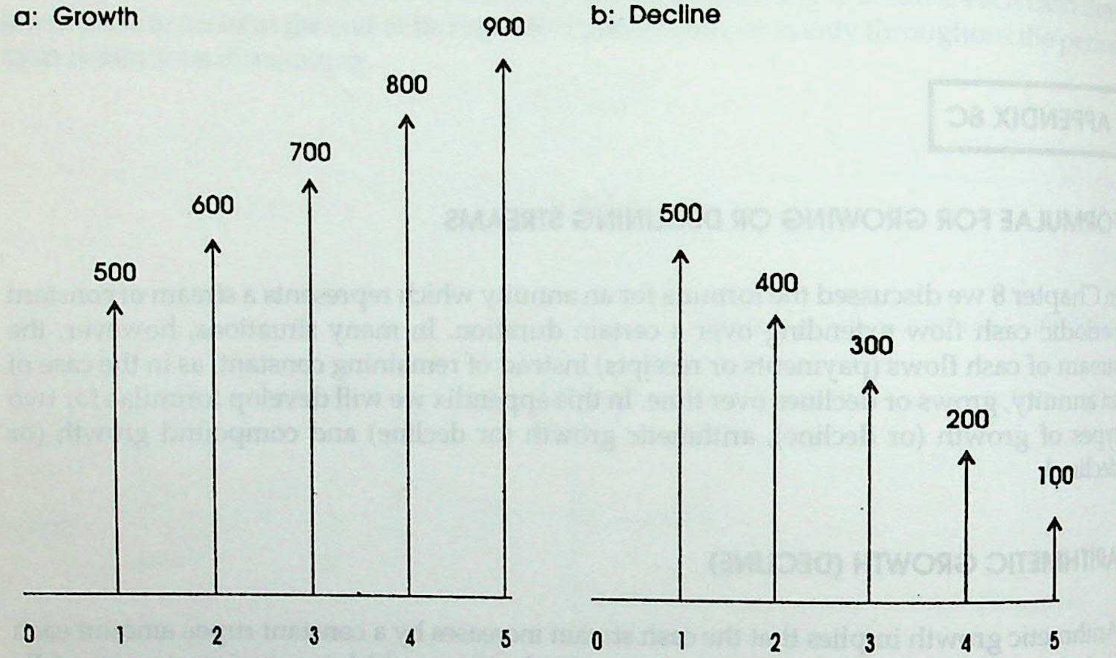
$$\begin{array}{lcl} \text{Present value of} & = \quad \text{Present value of} \quad \pm & \text{Present value of} \\ \text{a linearly growing} & \text{the annuity component} & \text{the growth component} \\ \text{(declining) cash stream} & & \end{array}$$

The formula for the present value of an annuity is known to us. What is the formula for the present value of the growth component? It is equal to:

$$PVG = \frac{1}{k}\left[\frac{(1+k)^{n}-1}{k(1+k)^{n}} - \frac{n}{(1+k)^{n}}\right] G \qquad (8C.1)$$

EXHIBIT 8C.1

Arithmetic Growth or Decline



where PVG = present value of the growth component
k = discount rate
n = duration of the cash flow stream
G = growth in rupees per year

$$\frac{1}{k}\left[\frac{(1+k)^{n}-1}{k(1+k)^{n}}-\frac{n}{(1+k)^{n}}\right]$$

is the present value interest factor for growth ($PVIGA_{k,n}$). It represents the present value of growth when the annual growth is one rupee and the duration of the cash stream is n years.

To derive the formula for $PVIGA_{k,n}$, the growth component may be broken into $n-1$ annuities as shown in Exhibit 8C.2.

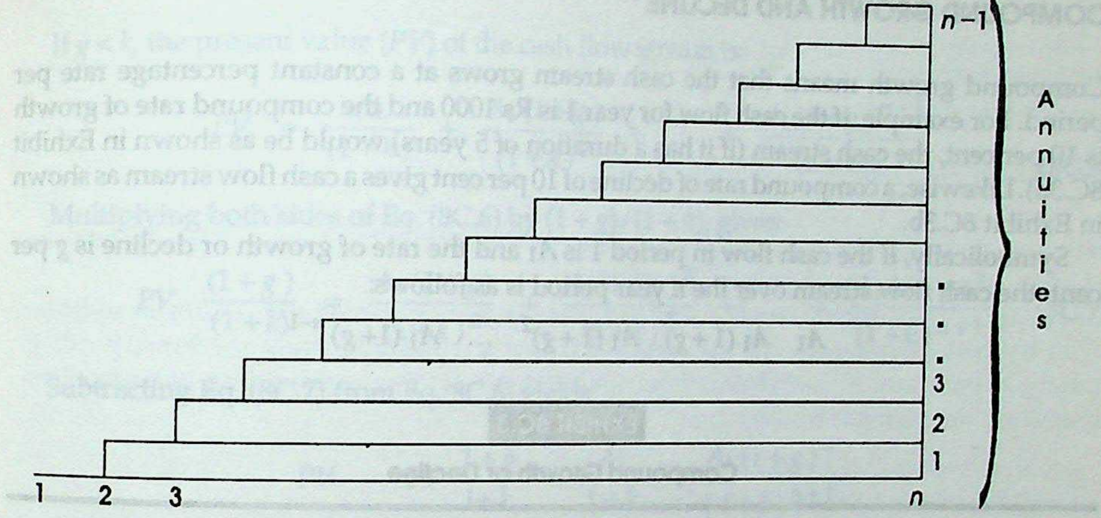
The present value of the first annuity which has a duration of $n-1$ years (as it starts at the end of year 2 and terminates at the end of year n) is equal to:

$$\left[\frac{(1+k)^{n-1}-1}{k(1+k)^{n-1}}\right]\frac{1}{(1+k)^{1}}=\frac{(1+k)^{n-1}-1}{k(1+k)^{n}} \tag{8C.2}$$

On the left hand side of Eq. (8C.2), the first term is $PVIFA_{k,n-1}$ and the second term is $PVIF_{k,1}$. The multiplication by the second term is necessary to obtain the value at the beginning of year 1 (that is at the end of year 0).

EXHIBIT 8C.2

Decomposition of the Growth Component into Annuities



The present value of the second annuity which has a duration of $n-2$ years (as it starts at the end of year 3 and terminates at the end of year n) is equal to:

$$\left[\frac{(1+k)^{n-2}-1}{k(1+k)^{n-2}}\right]\frac{1}{(1+k)^{2}} = \frac{(1+k)^{n-2}-1}{k(1+k)^{n}} \qquad (8C.3)$$

Likewise, the present values of the other annuities, totally numbering $n-1$, which are part of the growth component can be calculated. The sum of these is the *PVIGA*. Hence,

$$PVIGA\,(k, n) = \frac{(1+k)^{n-1}}{k(1+k)^{n}} + \frac{(1+k)^{n-2}-1}{k(1+k)^{n}} \;\dots + \frac{(1+k)^{1}-1}{k(1+k)^{n}}$$

$$= \frac{1}{k(1+k)^{n}}\left[(1+k)^{n-1}-1 + (1+k)^{n-2}-1 + \dots (1+k)^{1}-1\right]$$

$$= \frac{1}{k(1+k)^{n}}\left[\left\{(1+k)^{n-1} + (1+k)^{n-2} + \dots (1+k)^{1}\right\} - \left\{n-1\right\}\right]$$

$$= \frac{1}{k(1+k)^{n}}\left[\frac{(1+k)^{n}-1}{k} - n\right]$$

$$= \frac{1}{k}\left[\frac{(1+k)^{n}-1}{k(1+k)^{n}} - \frac{n}{(1+k)^{n}}\right]$$

$$= \frac{1}{k} \left[PVIFA_{k,n} - n \quad PVIF_{k,n} \right] \tag{8C.4}$$

COMPOUND GROWTH AND DECLINE

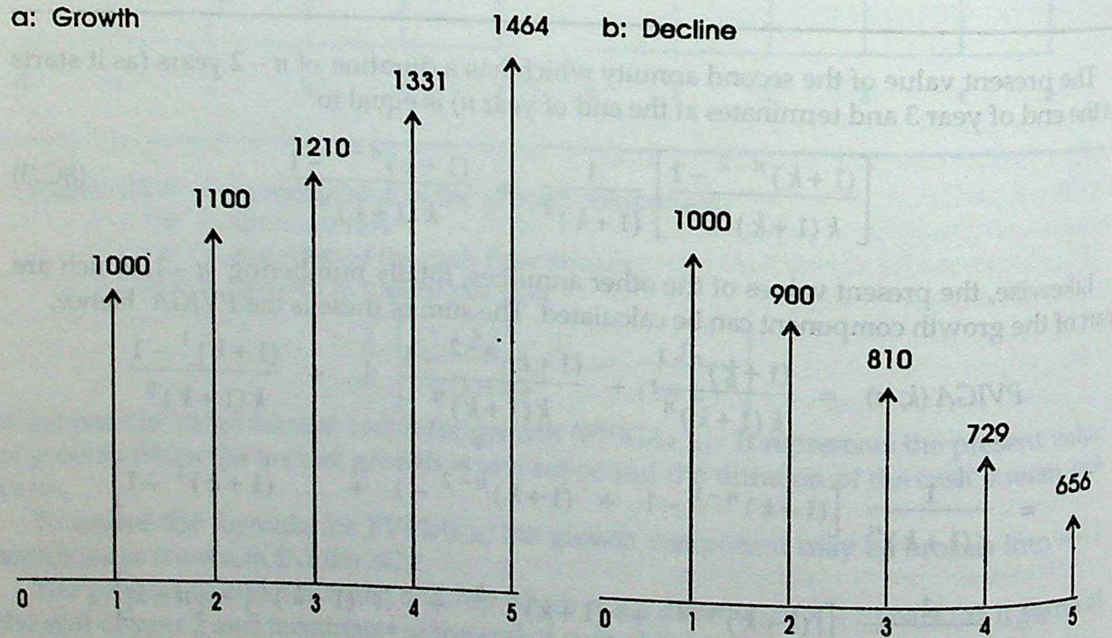
Compound growth means that the cash stream grows at a constant percentage rate per period. For example, if the cash flow for year 1 is Rs 1000 and the compound rate of growth is 10 per cent, the cash stream (if it has a duration of 5 years) would be as shown in Exhibit 8C.3a). Likewise, a compound rate of decline of 10 per cent gives a cash flow stream as shown in Exhibit 8C.3b.

Symbolically, if the cash flow in period 1 is A_1 and the rate of growth or decline is g per cent, the cash flow stream over the n year period is as follows:

$$A_1 \quad A_1(1+g) \quad A_1(1+g)^2 \quad \ldots \quad A_1(1+g)^{n-1}$$

EXHIBIT 8C.3

Compound Growth or Decline



The present value of such a cash flow stream depends on the relationship between g (the compound rate of growth of the cash flow stream) and k (the discount rate employed for calculating the present value). If $g = k$, the present value (PV) of the cash flow stream is:

$$PV = \frac{A_1}{(1+k)} + \frac{A_1(1+g)}{(1+k)^2} + \ldots + \frac{A_1(1+g)^{n-1}}{(1+k)^n}$$

$$= \frac{A_1}{(1+k)} + \frac{A_1}{(1+k)} + \dots \frac{A_1}{(1+k)}$$

$$= \frac{n\ A_1}{(1+k)} \qquad (8C.5)$$

If $g < k$, the present value (PV) of the cash flow stream is:

$$PV = \frac{A_1}{(1+k)} + \frac{A_1(1+g)}{(1+k)^2} + \dots + \frac{A_1(1+g)^{n-1}}{(1+k)^n} \qquad (8C.6)$$

Multiplying both sides of Eq. (8C.6) by $(1+g)/(1+k)$, gives:

$$PV\ \frac{(1+g)}{(1+k)} = \frac{A_1(1+g)}{(1+k)^2} + \frac{A_1(1+g)^2}{(1+k)^3} + \dots + \frac{A_1(1+g)^n}{(1+k)^{n+1}} \qquad (8C.7)$$

Subtracting Eq. (8C.7) from Eq.(8C.6) yields:

$$PV - PV\ \frac{1+g}{1+k} = \frac{A_1}{1+k} - \frac{A_1(1+g)^n}{(1+k)^{n+1}}$$

$$PV\ \frac{k-g}{1+k} = \frac{A_1}{1+k}\left[1 - \frac{(1+g)^n}{(1+k)^n}\right]$$

$$PV = \frac{A_1}{k-g}\left[1 - \frac{(1+g)^n}{(1+k)^n}\right] \qquad (8C.8)$$

APPENDIX 8D

GENERAL FORMULA

For answering the kinds of questions raised in Chapter 8, a general formula may be developed for the following types of problems.

A fund has a starting balance P. At the end of each period a 'change' of p occurs, in addition to the interest. (If p is paid into the fund, $p > 0$; if p is withdrawn from the fund, $p < 0$; if nothing is paid into or withdrawn from the fund, $p = 0$.) The outstanding balance earns interest at i per cent per annum.

Let x_t = balance in the fund at the end of t period.
From the above problem definition

$$x_0 = P \tag{8D.1}$$

$$x_{t+1} = x_t(1+i) + p \tag{8D.2}$$

Let us introduce a new variable

$$y_t = \frac{x_t + p/i}{(1+i)^t} \tag{8D.3}$$

So

$$x_t = y_t(1+i)^t - p/i \tag{8D.4}$$

According to the logic of (8D.4)

$$y_{t+1} = \frac{x_{t+1} + (p/i)}{(1+i)^{t+1}} \tag{8D.5}$$

Substituting the RHS of Eq.(8D.2) for x_{t+1} in Eq. (8D.5)

$$y_{t+1} = \frac{x_t(1+i) + p + p/i}{(1+i)^{t+1}}$$

$$= \frac{x_t + p/i}{(1+i)^t}. \tag{8D.6}$$

Thus, we find that successive values of y are same so all y_t's are equal to y_0.

Now

$$y_0 = \frac{x_0 + p/i}{(1+i)^0} = x_0 + p/i \tag{8D.7}$$

So

$$y_t = x_0 = p/i \tag{8D.8}$$

Substituting this in Eq. (8D.4)

$$x_t = (x_0 + p/i)\ (1+i)^t - p/i \tag{8D.9}$$

Since x_t is the sum at the end of period t, i.e.,

S, and X_0 is P

$$S = \left(P + \frac{P}{i}\right)(1+i)^t - \frac{P}{i} \tag{8D.10}$$

Equation (8D.10) is the general formula.

9

Cost of Capital

A firm's cost of capital is the rate of return it must earn on its investments for the market value of the firm to remain unaffected. It can also be regarded as the rate of return required by investors on capital provided by them. A central concept in financial management, linking the investment and financing decisions, the cost of capital is important for three reasons:

1. For a proper analysis of capital expenditure decisions, an estimate of the cost of capital is required. The cost of capital is the discount rate used in the net present value calculation and also the financial yardstick against which the internal rate of return is evaluated.
2. Several other decisions—like leasing, long-term financing, and working capital policy—require estimates of cost of capital.
3. In order to maximise the value of the firm, the costs of all inputs (including the capital input) must be minimised and in this context the firm should be able to measure the cost of capital.

This chapter discusses various aspects of the measurement of cost of capital. It is divided into ten sections as follows:

- Basic concepts, premises, and rationale
- Cost of debt capital
- Cost of preference capital
- Rate of return required by equity investors
- Cost of external equity and retained earnings
- Determination of weights
- Weighted average cost of capital
- Weighted marginal cost of capital schedule
- Weighted average cost of capital for a new company
- Cost of capital in practice

BASIC CONCEPTS, PREMISES, AND RATIONALE

Capital Components

In Chapter 7 we looked at three points of view from which a capital expenditure proposal may be evaluated: long-term funds point of view, equity point of view, and total funds point of view. The cost of capital measure must be consistent with the point of view adopted. Our present discussion is based on the long-term funds point of view—a point of view commonly advocated in financial literature. So the capital components relevant for our purpose are: equity capital (consisting of external equity as well as retained earnings), preference capital, and long-term debt capital (this includes term loans, debenture capital, and deferred credit arrangements).

It must be emphasised that current liabilities or short-term sources of funds (like working capital advance, trade credit, accruals, and provisions) that are used for financing working capital (current assets) are not part of capital components for our present purposes. How, then, are they reflected in the project appraisal exercise? While the annual financing burden (interest cost, commission charges, etc.) associated with them is provided for in the profitability projections, the retirement of the outstanding amount at the end of the project life is expected to be done from the proceeds realised from liquidation of current assets.

Average Cost of Capital

A firm's cost of capital is the weighted arithmetic average of the post-tax cost of various sources of long-term finance used by it. Suppose that a firm uses equity costing 16 per cent and debt costing 9 per cent. If the proportions in which equity and debt are used are respectively 40 per cent and 60 per cent, the cost of capital will be:

$$\begin{aligned}
\text{Cost of capital} &= \text{Proportion of equity} \times \text{Cost of equity} \\
&\quad + \text{Proportion of debt} \times \text{Cost of debt} \\
&= 0.40 \times 16\% + 0.6 \times 9\% \\
&= 6.4\% + 5.4\% \\
&= 11.8\%
\end{aligned}$$

In general, if the firm uses n different sources of finance, its cost of capital is:

$$k_a = \sum_{i=1}^{n} w_i k_i \tag{9.1}$$

where

k_a = average cost of capital
w_i = proportion or weight of the ith source of finance
k_i = cost of the ith source of finance

Cost of a Specific Source

As is evident from the above discussion, before we calculate the average cost of capital for the company, we should know the cost of specific sources of finance used by the company. How is the cost of a specific source of finance calculated? It is measured as the rate of discount which equates the present value of expected payments to that source of finance with the net funds received from that source of finance. In symbols, it is the value of k in the following equation.

$$P = \sum_{t=1}^{n} \frac{C_t}{(1+k)^t} \tag{9.2}$$

where P = net funds received from the source
C_t = expected payment to the source at the end of year t
n = maturity period

Historical Versus Marginal Cost

The historical cost (or embedded cost) of capital refers to the cost of funds raised in the past, whereas the marginal cost of capital reflects the cost of new or marginal funds. While the historical cost of capital may be important in some contexts (price control or rate regulation purposes), our interest will be in the marginal cost of capital. It must be emphasised that the weighted average cost of capital is used mainly for investment decisions and these decisions ought to be influenced by the cost of new capital and not the cost of capital raised in the past. Thus, for our purpose, the relevant cost is the marginal cost of funds proposed to be raised for financing investment projects during the planning period.

Rationale

The rationale for using the cost of capital as the hurdle rate in capital budgeting is fairly straightforward: If a firm's rate of return on its investments exceeds its cost of capital, the wealth of equity shareholders is enhanced. Why? When the firm's rate of return on its investments is greater than its cost of capital, the rate of return earned on equity capital (after meeting the costs of other forms of financing) will exceed the rate of return required by equity. Hence, the wealth of equity shareholders will increase. To illustrate this point, consider a firm whose cost of equity and debt are, respectively, 18 per cent and 10 per cent and which employs equity and debt in equal proportions. The cost of capital for the firm, which is the weighted average cost of capital, works out to 14 per cent. If the firm invests Rs 1 million, say, on a project which earns 18 per cent rate of return, the rate of return on equity funds will be:

$$\frac{\text{Total return on the project} \; - \; \text{Interest on debt}}{\text{Equity funds}} = \frac{100\,(.18) - 50\,(.10)}{50} = 26\,\%$$

Since 26 per cent exceeds the rate of return required by equity shareholders (18 per cent), the market value of equity capital, reflecting the wealth of equity shareholders increases.

Conditions for Using the Cost of Capital

Two basic conditions must be satisfied for using the average cost of capital to evaluate new investments:

Identical Risk Profile The risk of the investment proposal being considered is the same as the risk of the existing investments of the firm. In other words, the adoption of the investment proposal will not change the risk complexion of the firm.

Constancy of Capital Structure The capital structure of the firm will not be affected by the investment proposal. This means that the relative amounts of various sources of finance remain unchanged when the proposal is undertaken. Put differently the firm will continue to pursue the same financing policy[1].

Evaluating new projects when the above conditions are not fulfilled is a more complex and difficult proposition. Chapters 11 and 13 explore the methods available for coping with variations in risk and Chapter 12 discusses the adjustments required when investment and financing decisions are inter-related. The basic framework presented in this chapter, of course, will provide the foundation for understanding the methods and adjustments discussed in these later chapters.

COST OF DEBT CAPITAL

The cost of debt capital is the rate of discount which equates the present value of post-tax interest and principal repayments with the net proceeds of the debt issue. In symbols, it is the value of k_d, in the following equation, if the interest on debt is payable annually.

$$P = \sum_{t=1}^{n} \frac{C(1-T)}{(1+k_d)^t} + \frac{F}{(1+k_d)^n} \tag{9.3}$$

where P = net amount realised on debt issue
C = annual interest payable
T = tax rate applicable to the firm
F = redemption price
n = maturity period of debt

It may be noted that in Eq. (9.3), the annual debt interest payment is multiplied by the factor $(1 - T)$. This multiplication is necessary to reflect the fact that the interest on debt is a tax deductible expense. As a consequence, an interest payment of C in pre-tax terms means a post-tax payment of $C(1 - T)$. This is so because a tax-deductible interest expense of C brings a tax-shield of CT. This point may be clarified with the help of a numerical example. Consider two cases, A and B, which are as follows:

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[1] In practice, due to lumpiness in financing it may so happen that the mix of financing used for a project may not fully reflect the capital structure policy of the firm. This may be illustrated with an example. Suppose a firm's capital structure policy calls for employing debt and equity in equal proportions. The firm's investment plan consists of two projects, X and Y, each requiring an outlay of Rs 10 million. The total financing required for X and Y is Rs 200 million and this is proposed to be raised by issuing equity shares and debentures to the extent of Rs 100 million each. However, because of some 'lumpiness' in the process of financing, the firm would first raise Rs 100 million of equity financing when project X is undertaken and then it would raise Rs 100 million of debt financing when project Y is undertaken. In such a case it is reasonable to assume that each project is financed by a mix of debt and equity in equal proportions, though the specific sources of finance tapped at the time of undertaking X and Y happen to be equity and debt respectively. Put differently, the assumption is that each project is deemed to be financed from a pool of funds in which the various sources of long-term financing are represented in the proportions in which they are found in the capital structure.

	Case A	*Case B*
Earnings before interest and taxes (*EBIT*)	100	600
Interest (*I*)	–	60
Profit before tax (*PBT*)	100	40
Tax (*T*)	50	20
Profit after tax (*PAT*)	50	20

Comparing the two cases, it is evident that an interest payment of 60 in case *B* brings a tax shield of 30 which is 60 multiplied by 0.5, the tax rate. This implies that the post-tax cost of an interest payment of 60 is only 30. This is obvious when we compare the *PAT* figures for the two cases—in case *B* an interest payment of 60 entails a decline in *PAT* by only 30.

An Approximation

For obtaining a quick estimate, which is fairly close to the correct value, of the cost of the debt the following approximation may be used:

$$k_d \approx \frac{C(1-T) + (F-P)/n}{\frac{(P+F)}{2}} \tag{9.4}$$

Example Vikas Limited issues 14 per cent debentures, face value Rs 100. The net amount realised per debenture is Rs 94. The debentures are redeemable at a premium of Rs 5 after 7 years. The firm pays 50 per cent tax on its income. What is the cost of debt? The cost of debt, k_d, for Vikas Limited is approximately equal to:

$$\frac{C(1-T) + \frac{F-P}{n}}{\frac{(F+P)}{2}} = \frac{14(1-.5) + \frac{105-94}{7}}{\frac{(105+94)}{2}} = 8.3\%$$

Amortisation of the Cost of Issue

If the difference between *F* and *P* can be amortised evenly over the duration of debt finance, for tax purposes, the cost of debt capital is the value of k_d in the following equation:

$$P = \sum_{t=1}^{n} \frac{C(1-T) - \frac{(F-P)T}{n}}{(1+k_d)^t} + \frac{F}{(1+k_d)^n} \tag{9.5}$$

It may be noted that the term $(F-P)\,T/n$ in the numerator of the first component on the right hand side of Eq. (9.5) is the tax-shield arising out of the amortisation of issue cost.

An approximate value of k_d on the basis of Eq. (9.5) is as follows:

$$k_d \approx \frac{C(1-T) + \dfrac{(F-P)}{n}(1-T)}{\dfrac{(P+F)}{2}} \tag{9.6}$$

Term Loans from Financial Institutions

The term loans from financial institutions, which are a very important source of debt finance, have the following characteristics: (i) they are usually repayable over a period of 6 to 8 years in equal annual or half-yearly or quarterly instalments after an initial grace period of 1 to 3 years; (ii) the interest is payable on outstanding balance, (iii) there is hardly any issue expense, and (iv) there is no premium payable when the principal is repaid.

Given the above characteristics, the post-tax cost of a term loan is simply:

Interest rate (1 – tax rate)

Semi-annual Interest Payments

When interest is payable half-yearly, as is often the case, the cost of debt on a semi-annual basis is the value of k_d obtained on solving the following equation.

$$P = \sum_{t=1}^{2n} \frac{C(1-T)/2}{(1+k_d)^t} + \frac{F}{(1+k_d)^{2n}} \tag{9.7}$$

In this equation, the symbols have the same meaning as mentioned earlier except that the unit period is defined as six months and not one year. As a result, the number of periods doubles and k_d reflects the cost of debt on a semi-annual basis. The cost of debt, on an annual basis, will be:

$$(1+k_d)^2 - 1$$

COST OF PREFERENCE CAPITAL

Preference capital carries a fixed rate of dividend. Though this dividend is payable at the discretion of the board of directors, companies intend to pay the stated preference dividend regularly and preference shareholders expect to receive preference dividend regularly. The cost of preference capital which is redeemable is the value of k_p in the following equation.

$$P = \sum_{t=1}^{n} \frac{D}{(1+k_p)^t} + \frac{F}{(1+k_p)^n} \tag{9.8}$$

where
P = net amount realised per preference share
D = preference dividend per share payable annually
F = redemption price
n = maturity period

An Approximation

The cost of preference capital may be obtained quickly by using the following approximation.

$$k_p \approx \frac{D+(F-P)/n}{\dfrac{(P+F)}{2}} \qquad (9.9)^2$$

Example Himmat Limited issues Rs 100 face value preference shares carrying 14 per cent dividend which are repayable at par after 12 years. The net amount realised per share is Rs 92. What is the cost of preference capital?

The cost of preference capital, k_p, is approximately equal to:

$$\frac{D+\dfrac{(F-P)}{n}}{\dfrac{(P+F)}{2}} = \frac{14+\dfrac{(100-92)}{12}}{\dfrac{(100+92)}{2}} = 15.3 \text{ per cent}$$

Perpetual Preference Capital

The cost of preference capital which is perpetual is equal to k_p in the following equation.

$$P = \sum_{t=1}^{\infty} \frac{D}{(1+k_p)^t} \qquad (9.10)$$

where P = net amount realised per share of preference capital
D = preference dividend per share payable annually

The value of k_p in Eq. (9.10) is simply: $\dfrac{D}{P}$

RATE OF RETURN REQUIRED BY EQUITY INVESTORS

Equity capital is raised in two ways: (i) issue of external equity, and (ii) retention of earnings. Before determining the cost of equity capital raised by either of these means, we must first estimate the rate of return required by equity investors.

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[2] If the difference between F and P can be amortised equally over the life of the preference share, the cost of preference capital is the value of k_p in the equation

$$= \sum_{t=1}^{n} \frac{D-(F-P)T/n}{(1+k_p)^t} + \frac{F}{(1+k_p)^t}$$

Here, T stands for the tax rate; other symbols are the same as in Eq. (22.8). As per this equation:

$$k_p = \frac{D+(F-P)/n(1-T)}{\dfrac{(P+F)}{2}}$$

The rate of return required by the suppliers of debt capital and preference capital can be ascertained fairly easily because the benefits expected by them can be defined with near certainty. The estimation of the rate of return required by the equity shareholders, however, is difficult because the benefits expected by them cannot be measured easily. To cope with this difficult issue, several approaches have been proposed: dividend capitalisation approach; capital asset pricing model approach; realised yield approach; bond yield plus risk premium approach; and earnings—price approach.

Dividend Capitalisation Approach

The market price per share, as per the dividend capitalisation approach, is equal to the present value of the expected dividends, discounted at the return required by equity shareholders. In symbols

$$P_0 = \frac{D_1}{(1+k_s)} + \frac{D_2}{(1+k_s)^2} + \ldots \frac{D_\infty}{(1+k_s)^\infty} \qquad (9.11)$$

where P_0 = current market price per share of the equity stock
D_1 = dividend expected at the end of the year t
k_s = equity shareholders' required rate of return

Given the current market price per share of the equity stock, the rate of return required by equity shareholders can be calculated if the future dividend stream, as expected by equity shareholders, can be forecast.

If equity shareholders expect a constant dividend annually, the value of k_s in Eq. (9.11) is:

$$k_s = \frac{D}{P}$$

If equity shareholders expect the dividend to grow annually at a rate of g per cent forever, Eq. (9.11) becomes:

$$P_0 = \frac{D_1}{(1+k_s)} + \frac{D_1(1+g)}{(1+k_s)^2} + \frac{D_1(1+g)^2}{(1+k_s)^3} + \ldots \qquad (9.12)$$

$$k_s = D_1/P_0 + g \qquad (9.13)$$

Thus, investors expect to earn a dividend yield of D_1/P_0 and an annual capital appreciation of g, and hence a total return of k_s.

Example The market price per share of the equity of Hatari Limited is Rs 140. The dividend expected a year hence is Rs 5 per share and the dividend is expected to grow at a rate of 15 per cent per annum. What is the rate of return required by equity shareholders?

The rate of return required by equity shareholders is:

$$\begin{aligned} k_s &= D_1/P_0 + g \\ &= 5/140 + 0.15 \\ &= 0.036 + 0.15 \\ &= 0.186 = 18.6\% \end{aligned}$$

Estimating the Rate of Growth

The expected rate of growth of dividend per share is an important factor in calculating the cost of equity capital. It should be estimated as accurately as possible. The following guidelines are helpful in estimating the expected rate of growth.

1. If the rate of dividend growth has been fairly stable in the past, the past rate of dividend growth may be used as an approximation for the projected rate of dividend growth. Suppose the dividend per share for a company has been as follows:

Year	$t-8$	$t-7$	$t-6$	$t-5$	$t-4$	$t-3$	$t-2$	$t-1$	t
Dividend per share	1.00	1.10	1.20	1.35	1.45	1.60	1.70	1.85	2.00

From the above figures, we may say that the growth rate of dividend has been approximately 9 per cent. The figure of 9 per cent has been obtained by solving the following equation for g:

$$1.0\,(1+g)^8 = 2.0 \tag{9.14}$$

2. If the retention ratio (ratio of retained earnings to equity earnings) and the return on net worth (ratio of equity earnings to net worth) are quite stable, then the product of the average retention ratio and the average return on net worth in recent years can be used for calculating the expected growth rate. Suppose in the past 5 years the average retention ratio and the average return on net worth for a firm have been 0.5 and 15 per cent, respectively. The expected growth rate, based on these past figures, is:

$$0.5 \times 15 = 7.5\,\%$$

Realised Yield Approach

According to this approach the yield (rate of return) realised by equity shareholders historically is regarded as a proxy for the rate of return required by them. The yield on an equity stock is given by the following equation.

$$Y_t = \frac{D_t + P_t}{P_{t-1}} - 1 \tag{9.15}$$

where Y_t = yield for year t
D_t = dividend per share for t payable at the end of the year t
P_t = price per share at the end of year t
P_{t-1} = price per share at the end of year $t-1$, that is at the beginning of year t

$\frac{D_t + P_t}{P_{t-1}} - 1$ is referred to as the wealth ratio, W_t.

The yield for an n-year period is

$$(W_1 \times W_2 \times \ldots \times W_n)^{1/n} - 1 \tag{9.16}$$

where

$$W_1 = \frac{D_1 + P_1}{P_0}$$

$$W_2 = \frac{D_2 + P_2}{P_1}$$

$$\vdots$$

$$W_n = \frac{D_n + P_n}{P_{n-1}}$$

Example The yield calculation for an n-year period may be illustrated with an example. The dividend per share and price per share data of an equity stock are given below:

Year	1	2	3	4	5	6
Dividend per share	Rs 1.00	1.00	1.20	1.25	1.15	1.30
Price per share at the beginning	9.00	9.75	11.50	11.00	10.60	12.50

The annual wealth ratios are as follows:

Year	1	2	3	4	5
Wealth ratio	1.19	1.28	1.06	1.08	1.29

The geometric average return (yield) over the five-year period is:

$$(1.19 \times 1.28 \times 1.06 \times 1.08 \times 1.29)^{1/5} - 1$$

$$= (2.25)^{1/5} - 1 = 1.175 - 1 = 0.175 \text{ or } 17.5\%$$

The realised yield approach assumes that (i) the yield earned by investors has been, on average, in conformity with their expectations, and (ii) the future expectations of investors are similar to their past expectations. These conditions, particularly the second one, are somewhat unrealistic. (Changes in anticipated inflation rate and interest rate structure usually result in the revision of the rate of return required by investors.) Hence, caution must be exercised in using the realised historical yield as a proxy for the rate of return required by investors in future. The historical yield figure, however, can serve as a useful starting point for the estimation exercise.

Capital Asset Pricing Model Approach

One of the key relationships in the capital asset pricing model (CAPM)[3] is the security market line which is given by the following equation:

$$k_i = r_f + \beta_i \, (k_m - r_f) \tag{9.17}$$

where

k_i = rate of return required on security i
r_f = risk-free rate of return
β_i = beta of security i
k_m = rate of return on the market portfolio

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[3] The CAPM is covered in greater detail in a subsequent chapter.

To use the security market line relationship, we need the estimates of r_f, k_m, and β_i. r_f the risk-free rate of return may be taken as the rate of return on bank deposits of long-term nature. k_m, the rate of return on the market portfolio, is somewhat difficult to estimate. For practical purposes we may regard it as the rate of return earned on a well diversified portfolio. β_i measures the responsiveness of the return on security i to the return on the market portfolio. Assuming that the historical relationship will hold in future, the past beta may be used as the proxy for the future beta.

Example To illustrate the CAPM approach, let us assume that r_f =13 per cent and k_m = 18 per cent. The required rate of return on equity stocks with various betas is given below:

Beta	*Required rate of return*	$k_i = r_f + \beta_i\,(k_m - r_f)$
0.5	13 + 0.5(18 – 13)	= 15.5%
1.0	13 + 1.0(18 – 13)	= 18.0%
1.5	13 + 1.5(18 – 13)	= 20.5%

The CAPM approach is embedded in an elegant and rigorous theory. This approach, however, is crucially based on the assumption that investors eliminate unsystematic risk by efficient diversification and hence require compensation only for systematic risk which is reflected in beta. Market imperfections may impede efficient diversification by investors, exposing them to unsystematic risk. When this occurs, investors will require compensation for unsystematic risk, a factor which is not found in the security market line relationship. Another shortcoming of the CAPM relates to the instability of the betas of individual securities. Studies have shown that individual securities have unstable betas. This makes the use of historical beta as a proxy for the future beta somewhat questionable. Notwithstanding these shortcomings, the CAPM approach is a useful approach for estimating the required rate of return on equity stocks.

Bond Yield Plus Risk Premium Approach

According to this approach the rate of return required by the equity investors of a firm is equal to:

Yield on the long-term bonds of the firm + Risk premium

The logic of this approach is simple. Equity investors bear a higher degree of risk than bond investors, and hence their required rate of return should include a premium for this higher risk. The problem with this approach is how to determine the risk premium. Should it be 1 per cent, 2 per cent, or n per cent? There is no theoretical basis for estimating the risk premium. Most analysts look at the operating risk and financial risk characterising the business and arrive at a subjectively determined risk premium figure which varies normally between 2 per cent and 6 per cent. This is added to the yield on the firm's long-term bonds to estimate the rate of return required by equity investors.

Earnings Price Ratio Approach

According to this approach the rate of return required by equity investors is equated to

$$E_1/P_0 \tag{9.18}$$

where E_1 = expected earnings per share for the next year
P_0 = current market price per share.

E_1 may be estimated as: (Current earnings per share) × (1 + growth rate of earnings per share).

This approach provides an accurate measure of the rate of return required by equity investors in the following two cases:

A. When the earnings per share are expected to remain constant and the dividend payout ratio is 100 per cent.

B. When retained earnings are expected to earn a rate of return equal to the rate of return required by equity investors.

Case A is rarely encountered in real life. Case B is also somewhat unrealistic. Hence, the earnings-price ratio should not be used indiscriminately as the measure of the cost of equity capital.

COST OF EXTERNAL EQUITY AND RETAINED EARNINGS

Cost of External Equity

The cost of external equity is the rate of return the company must earn on the net funds raised by it when it issues equity capital externally so that the equity investors earn the required rate of return on their subscription to the equity capital of the firm. In order to derive the cost of external equity, the required rate of return has to be adjusted for underpricing and issue expenses. The nature of adjustment for the various approaches is discussed below:

Dividend Capitalisation Approach The required rate of return, as per the dividend capitalisation approach (when the dividend is expected to grow at a constant rate), is:

$$k_s = \frac{D_1}{P_0} + g \qquad (9.13)$$

In order to estimate the post-tax explicit cost of new equity issue, an adjustment has to be made for underpricing and issue expenses. If the net price realised per share by a company, as a result of underpricing and issue expenses, is $P_0(1-f)$, the cost of external equity (k_s) is defined as follows:

$$k_s = \frac{D_1}{P_0(1-f)} + g \qquad (9.19)[4]$$

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[4] This equation is derived as follows:

Step 1 The net price per share realised by the firm, $P_0(1-f)$, must be invested at a rate of returnk k_e which enables the new equity investors to enjoy a dividend stream D_t which old equity investors would enjoy. This means

$$P_0(1-f) = \sum_{t=1}^{n} \frac{D_t}{(1+k_e)^t} \qquad (1)$$

Step 2 When the growth is constant, Eq. (1) simplifies to:

$$P_0(1-f) = \frac{D_1}{k_e - g} \qquad (2)$$

Step 3 Eq. (2), when solved for k_e, yields:

$$k_e = \frac{D_1}{P_0(1-f)} + g \qquad (3)$$

It is clear that the difference between the cost of external equity (k_s), as given in Eq. (9.19), and the rate of return required by equity shareholders (k_s), as given in Eq. (9.13), arises because of underpricing and issue expenses.

Capital Asset Pricing Model and Other Approaches It appears that there is no generally agreed upon method to adjust for underpricing and issue expenses when the CAPM or the other approaches discussed earlier (viz., the realised yield approach, the bond yield plus risk premium approach, and the earnings price approach) are used. In the absence of such an agreement, we suggest the following adjustment may be used as a first approximation:

$$k_e = k_s/(1-f) \tag{9.20}$$

where k_e = cost of external equity

k_s = rate of return required by equity investors

f = underpricing and issue expenses expressed as a percentage of the current market price

Cost of Retained Earnings

Two basic approaches have been suggested for determining the cost of retained earnings: (i) tax-adjusted rate of return approach, and (ii) external yield approach.

Tax-adjusted Rate of Return Approach The cost of retained earnings is calculated as the post-tax rate of return available to the investor. This means that k_s has to be adjusted for ordinary and long-term capital gains tax as shown below:

$$k_r = k_s \; \frac{1-t_p}{1-t_g} \tag{9.21}$$

where k_r = cost of retained earnings

k_s = rate of return required by equity investors

t_p = ordinary personal income tax rate

t_s = personal long-term capital gains tax rate.

This approach is riddled with two problems: (i) The ordinary personal income-tax rate may vary widely across the shareholders of a company. Hence it may be impossible to establish a minimum rate of return that ensures that all the shareholders benefit if the company reinvests its cash flows instead of paying dividends. (ii) The alternative investment opportunities of the company are not considered.

External Yield Approach The basic premise of this approach is that the company should evaluate the possibility of buying shares of other companies with similar risk characteristics by using retained earnings. Hence the opportunity cost of retained earnings is deemed equal to the rate of return that can be earned on such investment. Since that rate of return is equal to k_s the cost of retained earnings is simply equal to k_s. This approach appears to be superior to the earlier approach. Hence, in our subsequent discussion we will adopt this approach.

DETERMINATION OF WEIGHTS

For calculating the weighted average cost of capital we multiply the cost of each source of finance by the weight applicable to it. Now that we know how to calculate the cost of specific sources of finance, we need to determine the weights [the w_i's in Eq. (9.1)]. These weights or proportions may be based on:

- Book values
- Financing plan
- Market values

Book Value Weights

Book value weights are based on the values found on the balance sheet. The weight applied to a given source of finance is simply the book value of that source of finance divided by the book value of total long-term financing.

The merits of book value weights are: (i) The calculation of weights is very simple. (ii) The weighted average cost of capital, based on book value weights, is likely to fluctuate less over time as book value weights are not affected by fluctuations in market prices. (iii) When market values are not obtainable or reliable, because the firm is not listed or the securities of the firm are not actively traded, book value weights may perhaps provide the only usable basis for computing the weighted average cost of capital. The disadvantages of book value weights are: (i) The present economic values of various sources of finance may bear no relationship to book values. (ii) Book value proportions are not consistent with the concept of cost of capital because the latter is defined as the minimum rate of return needed to maintain the market value of the firm.

Financing Plan Weights

The weights used under this system are the weights in which various sources of finance are proposed to be used to support the capital budget for the firm.

While this approach may appear appealing because it relies on the proposed financing plan, it has a serious drawback. It may be difficult to estimate the financing mix that will be used to finance current and future investments before assessing the profitability and the magnitude of investment outlay associated with the proposed capital budget. Yet an estimate of the cost of capital, based on the financing plan, is required before determining the capital budget.

Market Value Weights

According to this scheme of weighting, the proportion applied to a source of finance is equal to the market value of that source of finance divided by the market value of all sources of long-term finance employed by the firm.

The advantage of market value weights is this: Under the assumption that the firm's business and financial risk would remain unchanged, the cost of capital computed with current market cost and current market value weights is a valid measure of the minimum average return required on new investments.

The shortcomings of market value weights are: (i) Market values may not be obtainable when the firm is not listed or when the securities of the firm are very thinly traded. (ii) Market values may be distorted when security prices are influenced by speculative forces.

We recommend the use of market value weights unless market values are not available or highly unreliable or distorted.

WEIGHTED AVERAGE COST OF CAPITAL

Given the cost of specific sources of financing and the scheme of weighting, the weighted average cost of capital (WACC) can be readily calculated by multiplying the specific cost of each source of financing by its proportion in the capital structure and adding the weighted values. In symbols, the weighted average cost of capital may be expressed as follows:

$$k_a = w_d k_d + w_p k_p + w_s k_r \text{ (or } k_e) \qquad (9.22)$$

where
k_a = weighted average cost of capital
k_d = cost of long-term debt capital
k_p = cost of preference capital
k_r = cost of retained earnings
k_e = cost of external equity
w_d = proportion of long-term debt in the capital structure
w_p = proportion of preference capital in the capital structure
w_s = proportion of equity in the capital structure

Two points must be emphasised with reference to Eq. (9.22).

1. The sum of weights $(w_d + w_p + w_s)$ must be equal to 1. Put differently, all the components of capital structure must be accounted for.
2. The weight for equity, w_s, is multiplied by either the cost of retained earnings, k_r, or the cost of external equity, k_e. The specific cost used (k_r or k_e) will depend on whether equity is obtained by way of retained earnings or external equity issue.

Illustration

The cost of specific sources of capital for Bharat Nigam Limited are as follows:

Cost of debt, $k_d = 7.5$ per cent
Cost of preference capital, $k_p = 14.0$ per cent
Cost of retained earnings, $k_r = 16.0$ per cent
Cost of external equity, $k_e = 17.0$ per cent

The market value proportions in the company's target structure are as follows:

Source of capital	Market value proportions
Debt	0.45
Preference	0.05
Equity	0.50

As the firm expects to have substantial retained earnings, k_r is the relevant measure for the cost of equity as of now. Using this value along with the cost of other capital components the weighted average cost of capital for Bharat Nigam Limited is calculated in Exhibit 9.1. As shown there, it works out to 12.075 per cent.

EXHIBIT 9.1

Calculation of the Weighted Average Cost of Capital for Bharat Nigam Limited

Source of capital	Target proportion (1)	Cost (2)	Weighted cost [(1) × (2)]
Debt	0.45	7.5%	3.375%
Preference	0.05	14.0	0.700
Equity	0.50	16.0	8.000
			12.075

Weighted average cost of capital = 12.075 per cent.

WEIGHTED MARGINAL COST OF CAPITAL SCHEDULE

At the outset we assumed, *inter alia*, that the adoption of new investment proposals will not change either the risk complexion or the capital structure of the firm. Does it mean that the weighted average cost of capital will remain the same irrespective of the magnitude of financing? Apparently not. Generally, the weighted average cost of capital tends to rise as the firm seeks more and more capital. This happens because the supply schedule of capital is typically upward sloping—as suppliers provide more capital, the rate of return required by them tends to increase. A schedule or graph showing the relationship between additional financing and the weighted average cost of capital is called the weighted marginal cost of capital schedule.

Determining the Weighted Marginal Cost of Capital Schedule

The procedure for determining the weighted marginal cost of capital involves the following steps:

1. Estimate the *cost of each source of financing for various levels of its use* through an analysis of current market conditions and an assessment of the expectations of investors and lenders.
2. Identify the levels of total new financing at which the cost of the new components would change, given the capital structure policy of the firm. These levels, called *breaking points*, can be established using the following relationship.

$$BP_j = \frac{TF_j}{w_j} \tag{9.23}$$

where
BP_j = breaking point on account of financing source j
TF_j = total new financing from source j at the breaking point
w_j = proportion of financing source j in the capital structure

3. Calculate the *weighted average cost of capital for various ranges of total financing* between the breaking points.
4. Prepare the *weighted marginal cost of capital schedule* which reflects the weighted average cost of capital for each level of total new financing.

Illustration

To illustrate the preparation of the weighted marginal cost of capital schedule, let us consider an example. Shiva Chemicals Limited wishes to use equity, preference, and debt capital in the following proportions:

Equity : 0.45
Preference : 0.05
Debt : 0.50

Cost of each source of finance for various levels of its use Based on its discussions with its merchant bankers and lenders Shiva Chemicals Limited estimates that the cost of each of its three sources of financing for various levels of usage are given in Exhibit 9.2.

EXHIBIT 9.2

Data for Calculating the Weighted Marginal Cost of Capital (WMCC) Schedule for Shiva Chemicals Limited

Source of capital	Target proportion	Range of new financing*	Cost
Equity	45%	Rs 0 – Rs 10 million	15.00%
		Rs 10 million – Rs 30 million	16.50%
		Rs 30 million and above	18.00%
Preference	5%	Rs 0 – Rs 1 million	14.50%
		Rs 1 million and above	15.00%
Debt	50%	Rs 0 – Rs 15 million	7.50%
		Rs 15 million – Rs 40 million	8.00%
		Rs 40 million and above	8.40%

* These ranges are for the respective sources of financing and not for total new financing.

Breaking Points Given the target capital structure proportions and the financing ranges for each source of finance, the breaking points for each source of finance and the corresponding ranges of total new financing are given in columns 3 and 4 of Exhibit 9.3.

Weighted Average Cost of Capital for Various Ranges of Total New Financing An examination of column 4 of Exhibit 9.3 shows that the firm's weighted average cost of capital will change at the following levels of total new financing: Rs 20.00 million, Rs 22.22 million, Rs 30.00 million, Rs 66.67 million, and Rs 80.00 million. Exhibit 9.4 shows the calculation of the weighted average cost of capital over the ranges of total new financing.

EXHIBIT 9.3

Determination of Breaking Points and the Resulting Ranges of Total New Financing for Shiva Chemicals Limited

(in million)

Source of capital	Cost (1)	Range of new financing (2)	Breaking point (3)	Range of total new financing (4)
Equity	15.00%	Rs 0 – Rs 10	$\frac{\text{Rs } 10}{0.45}$ = Rs 22.22	Rs 0 – Rs 22.22
	16.50%	Rs 10 – Rs 30	$\frac{\text{Rs } 30}{0.45}$ = Rs 66.67	Rs 22.22 – Rs 66.67
	18.00%	Rs 30 and above	—	Rs 66.67 and above
Preference	14.50%	Rs 0 – Rs 1	$\frac{\text{Rs } 1}{.05}$ = Rs 20.00	Rs 0 – Rs 20.00
	15.00%	Rs 1 and above	—	Rs 20.00 and above
Debt	7.50%	Rs 0 – Rs 15	$\frac{\text{Rs } 15}{0.50}$ = Rs 30.00	Rs 0 – Rs 30.00
	8.00%	Rs 15 – Rs 40	$\frac{\text{Rs } 40}{0.50}$ = Rs 80.00	Rs 30.00 – Rs 80.00
	8.40%	Rs 40 and above	—	Rs 80.00 and above

EXHIBIT 9.4

Weighted Average Cost of Capital for Various Ranges of Total New Financing for Shiva Chemicals Limited

(in million)

Range of total new financing	Source of capital (1)	Proportion (2)	Cost (3)	Weighted cost [(2) x (3)] (4)
Rs 0 - Rs 20.00	Equity	0.45	15.00%	6.750%
	Preference	0.05	14.50	0.725
	Debt	0.50	7.50	3.750
Weighted average cost of capital				11.225
Rs 20.00 – Rs 22.22	Equity	0.45	15.00%	6.750%
	Preference	0.05	15.00	0.750
	Debt	0.50	7.50	3.750
Weighted average cost of capital				11.250
Rs 22.22 – Rs 30.00	Equity	0.45	16.50%	7.425%
	Preference	0.05	15.00	0.750
	Debt	0.50	7.50	3.750
Weighted average cost of capital				11.925

(Continued)

Exhibit 9.4 (Continued)

(in million)

Range of total new financing	Source of capital (1)	Proportion (2)	Cost (3)	Weighted cost [(2) x (3)] (4)
Rs 30.00 – Rs 66.67	Equity	0.45	16.50%	7.425%
	Preference	0.05	15.00	0.750
	Debt	0.50	8.00	4.000
Weighted average cost of capital				12.175
Rs 66.67– Rs 80.00	Equity	0.45	18.00%	8.100%
	Preference	0.05	15.00	0.750
	Debt	0.50	8.00	4.000
Weighted average cost of capital				12.850
Rs 80.00 and above	Equity	0.45	18.00%	8.100%
	Preference	0.05	15.00	0.750
	Debt	0.50	8.40	4.200
Weighted average cost of capital				13.050

Weighted Marginal Cost of Capital Schedule The weighted marginal cost of capital schedule is shown in Exhibit 9.5a. It is represented graphically in Exhibit 9.5b.

WEIGHTED AVERAGE COST OF CAPITAL FOR A NEW COMPANY

The two principal sources of finance (which often account for more than 90 per cent of financing) for a new company are equity capital and debt capital in the form of term loans. Hence the cost of capital for a new company may be put as:

$$k_a = w_e k_e + w_d k_d \tag{9.24}$$

where k_a = weighted average cost of capital
w_e = weight associated with external equity
k_e = cost of external equity
w_d = weight associated with debt
k_d = cost of debt

In applying the above formula to calculate the weighted average cost of capital of a new company two problems arise: (i) The calculation of the cost of equity for a new company is relatively more difficult. (ii) The weights associated with equity and debt for a new company vary over time.

Cost of Equity

Several questions lurk in the mind of an investor who considers subscribing to the equity capital of a new company: Will the company be able to produce quality goods? Will the company be able to obtain a high level of capacity utilisation? How would the products of the company be received in the market place? Investors, in general, perceive a higher degree of risk in the equity of a new company. Hence, they require a higher rate of return from equity investment in a new company. However, it is difficult to know the exact risk premium required by them.

EXHIBIT 9.5

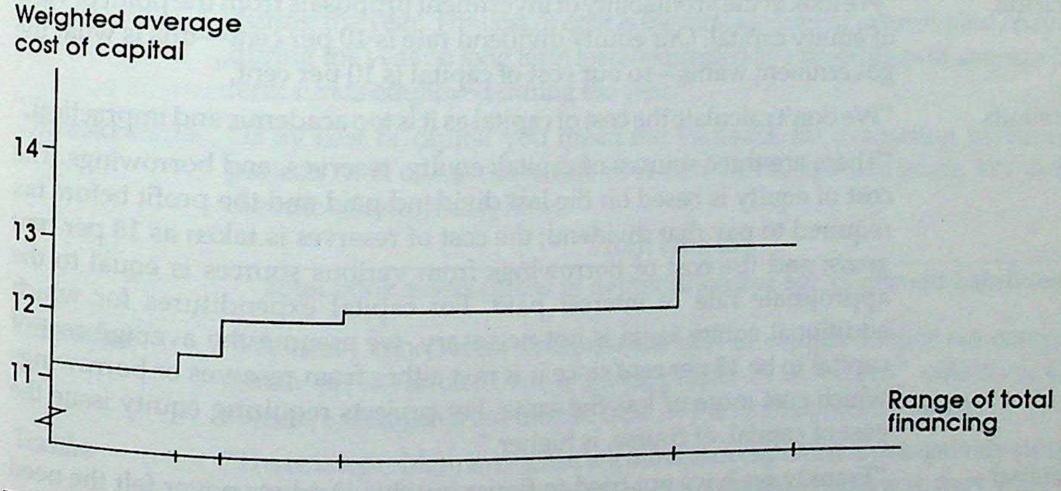
Weighted Marginal Cost of Capital Schedule

a : Tabular Presentation

(in million)

Range of total financing	Weighted average cost of capital %
Rs 0 – Rs 20.00	11.225
Rs 22.00 – Rs 22.22	11.250
Rs 22.22 – Rs 30.00	11.925
Rs 30.00 – Rs 66.67	12.175
Rs 66.67– Rs 80.00	12.850
Rs 80.00 and above	13.050

b: Graphical Presentation



Variation in Weights

Typically, the proportion of debt to equity for a new company declines over time. The explanation is fairly simple: While debt finance taken at the time of major investment (which occurs when the company is formed) diminishes over time as term loans are repaid, equity finance, thanks to retention of earnings, tends to increase over time. In view of this variation in debt-equity ratio over time, a question arises: What weights should be used in calculating the weighted average cost of capital? While it is difficult to answer this question, we may suggest an approach which, though somewhat crude, may be regarded as reasonably workable. This approach involves two steps: (i) Define the target capital structure of the firm. (ii) Use weights which are arithmetic averages of the weights in the initial capital structure and the target capital structure. To illustrate, suppose the debt-equity ratio in the target capital structure of the firm is 1:1, whereas the debt-equity ratio in the initial capital structure of the firm is 2:1. Given this information, the weights to be used in the weighted average cost of capital calculation would be:

$$w_e = \frac{1}{3} + \frac{1}{2} = \frac{5}{12}$$

$$w_d = \frac{2}{3} + \frac{1}{2} = \frac{7}{12}$$

COST OF CAPITAL IN PRACTICE

In order to understand how the cost of capital is calculated in practice, the author asked the Chief Finance Executives of twenty large-sized business undertakings, representing a wide cross-section of industries, the following question: How do you calculate the cost of capital? The responses obtained are shown below (the lengthier ones have been paraphrased):

Nature of industry	Response
Electrical	"We look at the profitability of investment proposals from the point of view of equity capital. Our equity dividend rate is 10 per cent—this is what the government wants—so our cost of capital is 10 per cent."
Chemicals	"We don't calculate the cost of capital as it is too academic and impractical."
Tea	"There are three sources of capital: equity, reserves, and borrowings. The cost of equity is based on the last dividend paid and the profit before tax required to pay that dividend; the cost of reserves is taken as 18 per cent gross; and the cost of borrowings from various sources is equal to the appropriate rate of interest paid. For capital expenditures for which additional equity issue is not necessary, we assume the average cost of capital to be 18 per cent since it is met either from reserves or borrowings which cost more or less the same. For projects requiring equity issue the cost of capital, of course, is higher."
Fertiliser	"Frankly we have not tried to figure out this. And we never felt the need to know it as our investments are carefully considered by an expert board of directors."
Toothpaste	"Our rate of return (profitability) is very high and thus it is not necessary to calculate the cost of capital."
Aluminium	"We equate cost of capital with the effective rate of interest on incremental borrowing necessary to finance capital expenditures. The specific type of borrowing determines the cost of capital."
Chemical	"We depend mainly on retained earnings which have no cost because shareholders are satisfied with dividends."

Automobile	"We don't go by cost of capital. Everything is dependent on investment opportunities. The decision maker will not wait to calculate ratios if he finds the investment opportunities worthwhile based on his business judgement."
Shipping	"Our normal debt-equity ratio is 3:1. Since the cost of equity and debt in post-tax terms are 18 per cent and 8 per cent respectively, our cost of capital is 10.5 per cent. However for the proposed new ship the cost is less because we propose to borrow up to 90 per cent."
Leasing	"Currently our debt-equity ratio is 5:1. The pre-tax cost of debt is about 18 per cent and the pre-tax cost of equity, given a dividend rate of 20 per cent, is 40 per cent. So our average cost of capital is: $5/6 \times 18 + 1/6 \times 40 = 21.7$ per cent."
Diversified	"Our return on investment—net profit to total assets—has varied between 10 per cent and 20 per cent in the last four years. So we take our cost of capital as 15 per cent."
Truck	"The cost of capital is calculated as the average of the cost of equity and the cost of debt. The cost of equity is the total amount of dividend for the year expressed as a percentage of the average shareholders funds employed during the year. The cost of debt is the total amount of interest paid/payable during the year on long term loans expressed as a percentage of average long term funds employed during the year."
Pharmaceuticals	"If by cost of capital you mean the yardstick for evaluating investment projects, it is our average rate of return for the last five years. We define the rate of return as follows: $\dfrac{\text{Profit after tax}}{\text{Total book assets (gross of depreciation but net of current liabilities)}}$."
Diversified	"We don't consciously compute the cost of capital. Rather we compare return on investment for a given project to a "return" objective. Our objective changes from time to time as the environment changes."
Textiles	"There is a problem in calculating the cost of capital. It is deceptively simple and it can be misleading. Moreover, if our managers know it, they will beat it."
Storage batteries	"All our financing is done with depreciation funds and ploughed back earnings. Depreciation is capital already in the company. Since it does not have to be raised, even in an indirect sense of retained earnings, it clearly has no cost."
Diversified	"In our investment decisions we don't go by numbers like cost of capital. We simply ask whether the proposed investment will improve the quality of our product and help us improve our competitive strength."
Consumer electronics	"Our return on equity historically has been around 25 per cent. Our cost of debt, adjusting for taxes, is about 10 per cent. By averaging the two, you get 17.5 per cent."

Diversified	"We look at the target specified by our foreign principal. I am not supposed to disclose it. But that in a way is our cost of capital."

Some Misconceptions

The cost of capital is a central concept in financial management linking the investment and financing decisions. Hence it should be calculated correctly and used properly in investment evaluation. Despite this injunction, we find that several errors characterise the practical application of this important concept. The more serious misconceptions, along with suggestions to overcome them, are discussed below:

Misconception: The concept of cost of capital is too academic or impractical

Some companies do not calculate the cost of capital because they regard it as 'academic' or 'impractical' or 'irrelevant' or 'imprecise'. These misgivings about cost of capital appear to be unjustified. Such reservations can be dispelled by emphasising the following points:

1. The cost of capital is an essential ingredient of discounted cash flow analysis that is now widely used. It can scarcely be considered 'academic' or 'impractical'.
2. Out of the various inputs required for discounted cash flow analysis, viz., project life, project cash flows (consisting of initial investment, operating cash flows, and terminal cash flow) and cost of capital, the last one, viz., cost of capital can be calculated most reliably and accurately. So a concern about its imprecision seems to be a misplaced concern.

Misconception: The cost of equity is equal to the dividend rate or return on equity

It appears that the cost of equity is often measured incorrectly. Most commonly it is measured as the current dividend rate (dividend per share as a percentage of face value per share) or as return on equity. Only by chance can these measures represent the cost of equity correctly.

It should be clearly understood that the cost of equity is the rate of return the firm should earn on the equity funds raised by it so that the expectations of equity shareholders are satisfied. It is the discount rate which equates the present value of the dividends expected by equity shareholders to the net amount raised by the firm. This discount rate, it must be emphasised, has no relationship whatsoever to the current dividend rate or return on equity, which are basically historical numbers.

Misconception: Retained earnings are either cost free or cost significantly less than external equity

Often firms impute a negligible or low cost to retained earnings under the influence of wrong notions like "retained earnings have no cost because shareholders are satisfied with dividends" or "retained earnings are already with the firm and hence some nominal returns on them may suffice."

The error in such reasoning stems from ignoring the opportunity cost associated with retained earnings. When a firm retains a portion of its earnings, equity shareholders are denied dividends to that extent. So ask the question, "If the company distributes, rather than retains, its earnings what happens?" A reasonable answer to this question is: Equity shareholders would have more funds with them which they would probably invest elsewhere to earn a rate of return comparable to the cost of equity. Hence the opportunity cost of retained earnings is more or less equal to the cost of equity funds.

Misconception: Depreciation has no cost

Similar to the misconception that retained earnings are more or less cost-free is the notion that depreciation–generated funds are also virtually cost free. Recall the observations of a participant in the survey: "Depreciation is capital already in the company. Since it does not have to be raised, even in an indirect sense of retained earnings, it clearly has no cost."

To guard against such an error invoke the opportunity cost principle once again. Theoretically the firm can return the depreciation–generated funds to its shareholders and lenders (the parties which provided the finance for asset acquisition) and they in turn can invest these funds elsewhere. Hence the opportunity cost of depreciation–generated funds is the average return the shareholders and lenders would earn on these funds by investing them elsewhere. And this would be more or less equal to the average cost of capital of the firm.

Misconception: The cost of capital can be defined in terms of an accounting-based measure

Some companies employ an accounting based measure like 'net profit to total assets' to define the cost of capital. This approach, however, is not correct. It looks at historical accounting information whereas what is relevant for cost of capital measurement is projected cash flows. It must be emphasised that to measure the cost of capital we have to take into account the future burden associated with the proposed sources of financing capital investments.

Misconception: If a project is heavily financed by debt, its weighted average cost of capital (WACC) is low

The lower post-tax cost of debt induces some financial managers to believe that greater reliance on debt for a particular project reduces its WACC. This confusion is evident in observations like "the specific type of borrowing determines the cost of capital" and "for the proposed new ship the cost is less because we plan to borrow up to 90 per cent."

To surmount the error in the above reasoning, remember the following:

1. WACC applies only to projects which are identical to the firm. Since the firm is not debt-financed to the extent of 90 per cent, it is wrong to use a weight of 0.9 for debt-financing in the calculation of WACC.
2. The immediate sources of funds used for a project do not necessarily determine the hurdle rate. What matters is the contribution made by the project to the firm's overall borrowing power and not which sources of funds happen to be tapped when the project is being undertaken.
3. Even if the firm is inclined and capable of going for 90 per cent debt financing, on an overall basis, the component costs of equity and debt are highly unlikely to remain what they are when the firm has 50 per cent debt financing.

SUMMARY

- A firm's cost of capital is the rate of return it must earn on its investments for the market value of the firm to remain unaffected. It can be regarded as the rate of return required by investors on capital provided by them.

- The capital components deemed relevant, in general, are: equity capital (consisting of external equity as well as retained earnings), preference capital, and long-term debt capital (this includes term loans, debenture capital, and deferred credit arrangement).
- A firm's cost of capital is the weighted arithmetic average of the post-tax cost of various sources of long-term finance used by it. In general, if the firm uses n different sources of finance, its cost of capital is:

$$k_a = \sum w_i k_i$$

Hence, to calculate the cost of capital for the firm, we need to know: (i) the cost of different sources of finance, and (ii) the proportions (weights) of different sources of finance in the capital structure of the firm.

- The cost of a specific source of finance is measured as the rate of discount which equates the present value of expected payments to that source with the net funds received from that source.
- Two conditions must be satisfied for using the average cost of capital to evaluate new investments: (i) The risk of the new investment proposal is the same as the risk of the existing investments. (ii) The capital structure of the firm will not be affected by the investment proposal.
- The cost of debt capital is the value of k_d in the following equation:

$$P = \sum_{t=1}^{n} \frac{C(1-T)}{(1+k_d)^t} + \frac{F}{(1+k_d)^n}$$

- The cost of redeemable preference capital is the value of k_p in the following equation:

$$P = \sum_{t=1}^{n} \frac{D}{(1+k_p)^t} + \frac{F}{(1+k_p)^n}$$

- While the rate of return required by the suppliers of debt capital and preference capital can be ascertained fairly easily, the rate of return required by equity shareholders is somewhat difficult. To cope with this difficult issue, several approaches have been proposed: dividend capitalisation approach; capital asset pricing model approach; realised yield approach; bond yield plus risk premium approach; and earnings-price approach.
- The cost of external equity is the rate of return the company must earn on the net funds raised by it when it issues equity capital externally so that the equity investors earn the required rate of return on their subscription to the equity capital of the firm. In order to derive the cost of external equity, the required rate of return has to be adjusted for underpricing and issue expenses.
- Two basic approaches have been suggested for determining the cost of retained earnings:
  (i) tax-adjusted rate of return approach, and
  (ii) external yield approach
- For calculating the weighted average cost of capital we multiply the cost of each source of finance by the weight (or proportion) applicable to it. The weights may be based on book values, or market values, or the financing plan. We recommend the use of

market value weights unless market values are not available or highly unreliable or distorted.

- Generally, the weighted average cost of capital tends to rise as the firm seeks more and more capital. This happens because the supply schedule of capital is typically upward sloping—as suppliers provide more capital, the rate of return required by them tends to increase.
- A schedule or graph showing the relationship between additional financing and the weighted average cost of capital is called the weighted marginal cost of capital schedule.
- In applying the formula to calculate the weighted average cost of capital of a new company two problems arise: (i) The calculation of the cost of equity for a new company is complicated by factors like tax rebate and higher perceived risk. (ii) The weights associated with equity and debt for a new company vary over time.
- There are certain misconceptions characterising the application of cost of capital in practice. The more common ones are: (a) The concept of cost of capital is too academic or impractical. (b) The cost of equity is equal to the dividend rate or return on equity. (c) Retained earnings are either cost free or cost significantly less than external equity. (d) Depreciation has no cost. (e) The cost of capital can be defined in terms of an accounting-based measure. (f) If a project is heavily financed by debt, its weighted average cost of capital is low.

QUESTIONS

1. State reasons for the importance of cost of capital.
2. How is the cost of a specific source of finance calculated?
3. What assumptions must be satisfied in order to use the average cost of capital for appraising new investments?
4. How would you measure the cost of debt capital and the cost of preference capital?
5. Discuss the guidelines for estimating the expected rate of growth to be used in conjunction with the dividend capitalisation approach.
6. Explain and evaluate the use of realised yield approach to calculate the rate of return required by equity shareholders.
7. Explain and evaluate the use of capital asset pricing model for estimating the rate of return required by equity shareholders.
8. Discuss how the cost of external equity may be established.
9. Discuss the approaches suggested for determining the cost of retained earnings.
10. Explain and evaluate the various bases for determining the proportions (weights) to be employed in calculating the weighted average cost of capital.
11. The financial controller of a company says: "Equity shareholders of our company have realised a yield of 16 per cent in the last five years. Hence our cost of equity is 16 per cent". Evaluate his argument.
12. The financial controller of a firm says: "Our present earnings per share are Rs 2.00 and the market price per share is Rs 25.00. Hence our cost of capital is 8 per cent (2/25)." Evaluate his argument.
13. Where will the breaks in the marginal cost of capital occur? Illustrate your answer with a suitable example.

14. Discuss the common misconceptions surrounding the use of cost of capital in practice.

PROBLEMS

1. Kapoor Limited issues 15 per cent debentures, face value Rs 100. The net amount realised per debenture is Rs 97. The debentures are redeemable at par after 10 years. The tax rate for the firm is 50 per cent. What is the cost of these debentures?
2. Vijay Electronics Limited issues 15 per cent debentures, face value Rs 500. The cost of issue works out to 3 per cent. The debentures are repayable after 7 years. The firm has a tax rate of 60 per cent. If the difference between the par value and the net amount realised can be amortised evenly over the life of the debentures, what is the cost of debentures to the firm?
3. Vaneeta Enterprises issues Rs 100 face value preference stock which carries 12 per cent dividend and is redeemable after 12 years at par. The net amount realised per preference share is Rs 95. What is the cost of preference capital?
4. The Superior Cement Company issues Rs 100 face value preference stock which carries 12 per cent dividend. The preference capital is repayable in two equal instalments at the end of the tenth and eleventh years, respectively. The net amount realised per preference share is Rs 95. What is the cost of preference capital?
5. Mysore Manufacturing Company issues Rs 100 face value debentures carrying interest of 15 per cent. The debentures are repayable in three annual instalments of Rs 30, Rs 30, and Rs 40 at the end of the seventh, eighth, and ninth year, respectively. The interest, of course, is payable only on the outstanding amount. The issue cost is 3 per cent. The tax rate of the company is 60 per cent. What is the cost of debenture capital to the company?
6. Bombay Electricals Corporation issues Rs 100 face value debentures carrying interest of 15 per cent. The debentures are repayable after 7 years at a premium of 5 per cent. The cost of issue is 3 per cent. The tax rate of the company is 50 per cent. The cost of issue can be amortised evenly over the life of the debentures. What is the cost of debenture capital?
7. The market price per share of Hazaribagh Company is Rs 17.00. The dividend expected a year is hence Rs 1.00. The expected rate of dividend growth is 8 per cent. What is the cost of equity of capital to the company?
8. The market price per share of a company presently is Rs 150. The dividend expected a year hence is Rs 12 per share. The dividend per share is expected to grow at a rate of 10 per cent per year for 5 years. Thereafter, the growth rate of dividend per share will decline to 6 per cent, a level which will be maintained forever. What is the cost of equity to the company?
9. Some financial statistics for Vidhi Limited are given below.

	0	1	2	3	4	5
Earnings per share	4.5	4.8	4.0	3.0	5.0	4.5
Dividend per share	3.0	3.0	3.0	2.0	3.0	3.0
Payout %	67.0	63.0	75.0	67.0	60.0	67.0
Bonus	–	–	–	1:2	–	–
Average price	40.0	42.0	45.0	33.0	38.0	36.0
Book value per share	30.0	31.8	32.8	23.5	25.5	27.0

Calculate the cost of equity capital.

10. The risk-free rate is 8 per cent and the return on market portfolio is 12 per cent. Calculate the required rate of return on three equity stocks with the beta values shown against them:

Stock	*Beta*
A	0.8
B	1.2
C	1.7

11. Elegant Papers Company has the following market capital structure as on 31.12.19 × 0.

Debt (term loans, 12%)	Rs 30 million
Equity capital	Rs 20 million
Retained earnings	Rs 40 million
Market value of equity	Rs 50 million

Earnings per share and dividend per share have grown steadily, almost at the same rate, over the last seven years. Dividend per share has increased in this period from Rs 2.00 to Rs 3.00. It is expected to grow in future, too, at the same rate. The market price per share as on 31/12/19 × 0 is Rs 40. The tax rate for the company is 60 per cent. Calculate the average cost of capital for Elegant Papers Company.

12. The Sterling Company's next expected dividend per share is Rs 2.50, its growth rate is 6 per cent, and the stock currently sells for Rs 25.00 per share. Additional equity can be sold to public to net Rs 21.00 per share.

Calculate (a) Sterling's floatation cost
(b) Sterling's cost of external equity

13. Panyam Company's capital structure in terms of market value is:

Debt	Rs 30 million
Equity	Rs 60 million

The company plans to maintain this market-value capital structure. The company has a plan to invest Rs 15 million next year. This will be financed as follows:

Retained earnings	Rs 5 million
Additional equity	Rs 5 million
Debt	Rs 5 million

The company's equity stock presently sells for Rs 30 per share. The next dividend expected is Rs 3.00. The expected rate of dividend growth is 5 per cent. Additional equity can be issued at Rs 25 per share (net). The interest rate applicable to additional debt would be as follows:

First Rs 2.5 million	14 per cent
Next Rs 2.5 million	15 per cent

The tax rate for the firm is 60 per cent.

Required (a) At what amounts of new capital will there be breaks in the marginal cost of capital schedule?
(b) What will be the marginal cost of capital in the interval between each of the breaks?

14. Susheel Corporation has the following book value capital structure.

Equity Capital (1 million shares, Rs 10 par)	Rs 10 million
Preference Capital, 11 per cent (10,000 shares, Rs 100 par)	Rs 1 million
Retained earnings	Rs 12 million
Debentures, 13.5 per cent (50,000 debentures, Rs 100 par)	Rs 5 million
Term loans, 12 per cent	Rs 8 million
	Rs 36 million

The next expected dividend per share is Rs 1.50. The dividend per share is expected to grow at the rate of 7 per cent. The market price per share is Rs 20.00. Preference stock, redeemable after 10 years, is currently selling for Rs 75.00. Debentures, redeemable after 6 years, are selling for Rs 80.00. The tax rate for the company is 50 per cent.

(a) Calculate the average cost of capital using
  (i) book value proportions, and
  (ii) market value proportions

(b) Define the marginal cost of capital schedule for the firm if it raises Rs 10 million next year, given the following information:
  (i) the amount will be raised from equity and debt in equal proportions;
  (ii) the firm expects to retain Rs 1.5 million earnings next year;
  (iii) the additional issue of equity stock will fetch a net price per share of Rs 16.00;
  (iv) the debt capital raised by way of term loans will cost 14 per cent for the first Rs 2.5 million and 15 per cent for the next Rs 2.5 million.

15. Zenith Metals Limited wishes to use equity, preference, and debt capital in the following proportions:

Equity	0.40
Preference	0.10
Debt	0.50

The management of Zenith Metals Limited, based on its discussions with merchant bankers and lenders, estimates that the cost of each of its three sources of financing for various levels of usage are as follows:

Source of capital	Range of new financing	Cost
Equity	Rs 0 – Rs 20 million	16.00%
	Rs 20 million – Rs 50 million	17.00%
	Rs 50 million and above	18.00%
Preference	Rs 0 – Rs 5 million	15.00%
	Rs 5 million and above	16.00%
Debt	Rs 0 – Rs 25 million	7.80%
	Rs 25 million – Rs 60 million	8.20%
	Rs 60 million and above	8.50%

(a) Calculate the breaking points for each source of finance and the corresponding ranges of total financing.

(b) Determine the weighted average cost of capital over the ranges of total new financing.

(c) Develop the weighted marginal cost of capital schedule.

APPENDIX 9A

EARNINGS-PRICE (*E/P*) RATIO AS A MEASURE OF COST OF EQUITY

E/P ratio measures the cost of equity capital in the following cases:

Case A Future earnings are constant and the payout ratio is 100 per cent.

Case B The firm invests in projects that earn a rate of return of k_e, (the cost of equity capital) for ever on the equity portion of financing.

Case A The cost of equity is the value of k_e, in the equation.

$$P = \sum_{t=1}^{\infty} \frac{D_t}{(1+k_e)^t} \tag{9A.1}$$

When future earnings are constant and the payout ratio is 100 per cent:

$$E_1 = E_2 = E_3 = \ldots E = D_1 = D_2 = \ldots D \tag{9A.2}$$

Putting future earnings as E gives

$$P = \sum_{t=1}^{\infty} \frac{E}{(1+k_e)^{t}}. \tag{9A.3}$$

This leads to:

$$k_e = E/P \tag{9A.4}$$

Case B For the sake of simplicity, let us assume that the firm has an all-equity capital structure and the retention ratio is b (a constant) in each period.

Since reinvested funds earn a rate of return of k_e per cent, earnings, retained earnings, and dividends will be as given in Exhibit 9A.1.

EXHIBIT 9A.1

Earnings, Retained Earnings, and Dividends

Year	Earnings	Retained earnings	Dividends
0	E_0	$E_0 b$	$E_0(1-b)$
1	$E_0 + E_0\, b k_e = E_0(1+bk_e)$	$E_0(1+bk_e)b$	$E_0(1+bk_e)(1-b)$
2	$E_0(1+bk_e) + E_0(1+bk_e)bk_e$ $= E_0(1+bk_e)^2$	$E_0(1+bk_e)^2 b$	$E_0(1+bk_e)^2(1-b)$
.	.	.	.
.	.	.	.
.	.	.	.
n	$E_0(1+bk_e)^n$	$E_0(1+bk_e)^n b$	$E_0(1+bk_e)^n(1-b)$

The cost of equity is the value of k_e in the following equation:

$$P = \sum_{t=1}^{\infty} \frac{D_t}{(1+k_e)^t} \tag{9A.5}$$

Given the values of D_t in Exhibit 9A.1, we get

$$P = \sum_{t=1}^{\infty} \frac{E_0\ (1+b\,k_e)^t\,(1-b)}{(1+k_e)^t}$$

$$= \sum_{t=1}^{\infty} E_0\,(1-b)\,\frac{(1+b\,k_e)^t}{(1+k_e)^t}$$

$$= \frac{E_0\,(1-b)\,(1+bk_e)}{k_e\,(1-b)} \tag{9A.6}$$

Hence $$k_e = E_1/P \tag{9A.7}$$

APPENDIX 9B

COST OF DEPRECIATION-GENERATED FUNDS

Generally, depreciation-generated funds represent a very important source of funds. For purposes of capital budgeting, what cost should be imputed to such funds? The cost to be imputed to such funds should be more or less the average cost of capital to the firm. The rationale behind this argument is that the firm could theoretically return the depreciation-generated funds to its shareholders and lenders (the parties which provided the finance for asset acquisition) and they in turn can invest the funds elsewhere. Hence the opportunity cost of depreciation-generated funds is the average return the shareholders and lenders would earn on these funds by investing them elsewhere. And this would be more or less comparable to the average cost of capital to the firm.

Since the cost of depreciation-generated funds is more or less equal to the average cost of capital of the firm, it does not matter if we exclude it from the cost of capital computation. This is clear from the following analysis, where, for the sake of simplicity, we assume that there are only two sources of finance, debt and equity, in addition to depreciation-generated funds.

The weighted average cost of capital when depreciation-generated funds are not explicitly considered is:

$$k_a = w_d k_d + w_e k_e \tag{9B.1}$$

where k_a = weighted average cost of capital
k_d = weight associated with debt capital
k_d = cost of debt capital
w_e = weight associated with equity capital
k_e = cost of equity capital

The weighted average cost of capital when depreciation-generated funds are explicitly considered is:

$$k_a = w'_d k_d + w'_e k_e + w_{\text{dep}} k_{\text{dep}} \tag{9B.2}$$

where k_a = weighted average cost of capital
w'_d = weight associated with debt capital
k_d = cost of debt capital
w'_e = weight associated with equity capital
k_e = cost of equity capital
w_{dep} = weight associated with depreciation-generated funds
k_{dep} = cost of depreciation-generated funds

It may be noted that as the sum of the weights in each of the Eqs. (9B.1) and (9B.2) is necessarily 1, the following conditions are satisfied:

$$w_d + w_e = 1 \tag{9B.3}$$

$$w'_d + w'_e + w_{\text{dep}} = 1 \tag{9B.4}$$

Comparing Eqs (9B.3) and (9B.4), we find that w_d in Eq. (9B.3) gets reduced to w'_d in Eq. (9B.4) and w_e in Eq. (9B.3) gets reduced to w'_e in Eq. (9B.4). These reductions are caused to accommodate w_{dep} in Eq. (9B.4). Since the reductions in w_d and w_e will be in the same proportions (that means if w_d reduces by x percentage, w_e will also reduce by x percentage) to accommodate w_{dep} we get the following relationships:

$$w'_d = w_d\ (1 - w_{\text{dep}}) \tag{9B.5}$$

$$w'_e = w_e\ (1 - w_{\text{dep}}) \tag{9B.6}$$

As the cost of depreciation-generated funds is equal to the weighted average cost of capital (i.e., $k_{\text{dep}} = k_a$), Eq. (9B.2) can be re-written as:

$$k_a = w'_d\, k_d + w'_e\, k_e + w_{\text{dep}}\, k_a \tag{9B.7}$$

Juggling Eq. (9B.7) a bit, we get:

$$k_a = \frac{w'_d}{(1 - w_{\text{dep}})}\, k_d + \frac{w'_e}{(1 - w_{\text{dep}})}\, k_e \tag{9B.8}$$

As

$$w_d = \frac{w'_d}{(1 - w_{\text{dep}})}$$ (This is derived from Eq.(9B.5))

and

$$w_e = \frac{w'_e}{(1 - w_{\text{dep}})}$$ (This is derived from Eq.(9B.6))

Equations (9B.8) and (9B.1) are identical. Thus, depreciation-generated funds need not enter the calculation of the weighted average cost of capital. Hence, we can employ Eq. (9B.1) for calculating the cost of capital.

Depreciation-generated funds, of course, do affect the cost of capital schedule. If we look at Exhibit 9.5 in Chapter 9 we find that the cost of capital schedule begins to increase when the total amount of funds raised exceeds Rs 20 million. If depreciation-generated funds are considered, the first segment in the cost of capital schedule will be extended by the amount of depreciation-generated funds. In that example, if depreciation-generated funds are Rs 5 million, the cost of capital schedule will rise at Rs 25 million rather than at Rs 20 million. The implications of this are as follows:

(a) When gross capital expenditure (which include replacement as well as expansion investments) are considered, the schedule should include depreciation-generated funds.

(b) When net capital expenditures are considered, the schedule should not include depreciation-generated funds.

APPENDIX 9C

SYSTEMS OF WEIGHTING FOR DETERMINING THE COST OF CAPITAL

In order to discuss the various systems of weighting which may be employed in computing the weighted average cost of capital, let us look at an example. Zenith Limited has the following capital structure at present:

		Book Value	Market Value
Equity	:	200	400
Debt	:	100	80

Zenith is planning to raise further capital of 200 in the following manner:

Equity : 100
Debt : 100

The market value of this capital would be:

Equity : 120
Debt : 100

Zenith is aiming at a target capital structure in which equity and debt are in equal proportions. The management of the firm is not clear whether these equal proportions should be with respect to book values or market values.

Given the above information, we may prepare Exhibit 9C.1 showing the proportions of equity and debt in terms of book values and market values in:

(i) the existing capital structure (i.e., the present capital structure),
(ii) the marginal financing plan (i.e., the financing plan the firm wants to use to raise capital at the margin),
(iii) the emergent capital structure (i.e., the capital structure which will emerge when the marginal financing plan is implemented),
(iv) the bridging financing plan (i.e., the financing scheme which will enable the firm to reach its target capital structure from its present capital structure), and
(v) the target capital structure (i.e., the capital structure the firm wants to attain eventually because it considers it as the most desirable capital structure).

In general, weights based on book values are not suitable as book values often do not reflect economic values. So, we will focus our discussion on weights based on market values.

Market Values in the Existing Capital Structure While market values in the existing capital structure are observable easily, their use hinges on whether the existing capital structure conforms to the target capital structure. Often the existing capital structure is at variance with the target capital structure. In such a case, market values in the existing capital structure may not be very appropriate for determining the weights.

Market Values in the Marginal Financing Plan It may be possible to estimate fairly accurately the market values for the marginal financing plan. However, since financing tends to be 'lumpy', the marginal financing plan may be very different from the target capital structure. Hence, market values in the marginal financing plan may not be very suitable for establishing the weights.

Market Values in the Emergent Capital Structure These values can be used depending on the extent to which the emergent capital structure corresponds with the target capital structure.

Market Values in the Bridging Financing Plan The financing plan which bridges the gap between the present capital structure and the target capital structure is referred to as the bridging financing plan. Since this represents the incremental scheme of financing sought by the firm, market values in this scheme appear to be suitable for determining the weights. However, there is a problem here. The weights as per this scheme differ from one level of total financing to another level of total financing, even though the target capital structure remains the same. This is evident when we look at the 'Bridging Financing Plan' portion of Exhibit 9C.1.

EXHIBIT 9C.1

Different Systems of Weighting

	Existing capital structure		Marginal financing plan		Emergent capital structure		Bridging financing plan				Target capital structure	
							Target: 2000		Target: 4000			
	Book Value	*Market Value*	*Book Value*	*Market Value*	*Book Value*	*Market Value*	*Book Value*	*Market Value*	*Book Value*	*Market Value*	*Book Value*	*Market Value*
Equity	200	400	100	120	300	520	800	600	1800	1600	Proportion of equity and debt: 1:1	Proportion of equity and debt: 1:1
Debt	100	80	100	100	200	180	900	920	1900	1920		

Market Values in the Target Capital Structure This appears to be the most appropriate basis as it takes into account the long-term point of view. However, it presupposes that the firm has determined its target capital structure. The critics may argue that when a firm has not articulated its capital structure, this approach is not feasible. The following counter-argument may be offered: "Even though a firm may not have defined its target capital structure definitely, it can specify a desirable capital structure tentatively. The weights as per this tentative capital structure may be applied, till the target capital structure is articulated."

10

Appraisal Criteria

Once the stream of costs and benefits for a project is defined in the form of cash flows (or accounting figures as is sometimes done), the attention shifts to the issue of project worthwhileness. A wide variety of appraisal criteria (or evaluation methods) have been suggested to judge the worthwhileness of capital projects. More than thirty criteria have been proposed, in the extensive literature on this subject, to guide investment decision making. Some are general and applicable to a wide range of investments; others are specialised and suitable for certain types of investments or industries. The more important and popular of these can be classified into two broad categories as follows:

Discounting Criteria	**Non-discounting Criteria**
Net present value	Urgency
Benefit-cost ratio	Payback period
Internal rate of return	Accounting rate of return

This chapter discusses these criteria in some detail. In addition, it looks at how investment appraisal is done in practice, both in India as well as abroad.

NET PRESENT VALUE

The net present value of a project is equal to the sum of the present value of all the cash flows associated with it. Symbolically,

$$NPV = \frac{CF_0}{(1+k)^0} + \frac{CF_1}{(1+k)^1} + \dots + \frac{CF_n}{(1+k)^n} = \sum_{t=0}^{n} \frac{CF_t}{(1+k)^t} \qquad (10.1)$$

where NPV = net present value

CF_t = cash flow occurring at the end of year t ($t = 0,\dots n$). A cash inflow has a positive sign, whereas a cash outflow has a negative sign

n = life of the project

k = cost of capital

To illustrate the calculation of net present value, consider a project which has the following cash flow stream:

Year	Cash flow
0	–1,000,000
1	200,000
2	200,000
3	300,000
4	300,000
5	550,000

If the cost of capital, *k*, is 10 per cent, the net present value of the project is:

$$NPV = \frac{1{,}000{,}000}{(1.10)^0} + \frac{200{,}000}{(1.10)^1} + \frac{200{,}000}{(1.10)^2} + \frac{300{,}000}{(1.10)^3} + \frac{300{,}000}{(1.10)^4} + \frac{550{,}000}{(1.10)^5} = 118{,}750$$

The decision rule associated with the net present value is: Accept the project if its net present value is positive and reject it if its net present value is negative (if the net present value is zero, it is a matter of indifference).

Rationale for the NPV Method

The *NPV* method has a straight-forward rationale. An *NPV* of zero signifies that the benefits of the project (project cash inflows over time) are just enough to (a) recoup the capital invested and (b) earn the required return on the capital invested. A positive *NPV* implies that the project earns an excess return. Since the return to the providers of debt capital is fixed, the excess return accrues solely to equity shareholders, thereby augmenting their wealth. In our example, the project has an *NPV* of Rs 118,750 and this represents a direct measure of the rupee benefit (in present value terms) of the project for the firm's shareholders.

Features of the Net Present Value Method

Two features of the net present value method may be emphasised:

1. The net present value method is based on the assumption that the intermediate cash inflows of the project are re-invested at a rate of return equal to the cost of capital.
2. The net present value of a simple project steadily decreases as the discount rate increases. The decrease in net present value, however, is at a decreasing rate. (A simple project involves an initial cash outflow, or a series of initial cash outflows, followed by subsequent cash inflows.)

Modified Net Present Value

The standard net present value method is based on the assumption that the intermediate cash flows are re-invested at a rate of return equal to the cost of capital. When this assumption is not valid, the re-investment rates applicable to the intermediate cash flows need to be defined for calculating the modified net present value. The steps involved in this process are as follows:

Step 1 Calculate the terminal value of the project's cash inflows using the explicitly defined reinvestment rate(s) supposed to reflect the profitability of investment opportunities ahead of the firm.

$$TV = \sum_{t=1}^{n} CF_t \; (1+r')^{n-t} \qquad (10.2)^1$$

where TV = terminal value of the project's cash inflows
CF_t = cash inflow at the end of year t
r' = re-investment rate applicable to the cash inflows of the project

Step 2 Determine the modified net present value

$$NPV^* = \frac{TV}{(1+k)^n} - I \qquad (10.3)$$

where NPV^* = modified net present value
TV = terminal value
k = cost of capital
I = investment outlay

To illustrate the calculation of NPV^*, consider two projects, X and Y:

	Project X	**Project Y**
Investment outlay	**Rs 110,000**	**Rs 110,000**
Cash inflows		
Year 1	31,000	71,000
Year 2	40,000	40,000
Year 3	50,000	40,000
Year 4	70,000	20,000

The NPV^* for X and Y may be calculated for two re-investment rates, 14 per cent and 20 per cent, assuming a cost of capital of 10 per cent.

---

[1] Equation (10.2) is based on the assumption that all the intermediate cash inflows are investible at the same rate of return, r'. If the re-investment rates differ then the terminal value may be calculated as follows:

$$TV = \sum_{t=1}^{n} CF_t \left[\mathop{\pi}\limits_{j=t+1}^{n} (1+r'_j) \right]$$

where TV = terminal value of the project's cash inflows
CF_t = cash inflow at the end of year t
r'_j = re-investment rate applicable during period j

Step 1 The terminal values of the cash inflows of projects *X* and *Y* for the two re-investment rates are:

$$\begin{aligned}
TV\,(X)_{14\%} &= 31{,}000(1.14)^3 + 40{,}000(1.14)^2 + 50{,}000(1.14) + 70{,}000 \\
&= \text{Rs } 224{,}911 \\
TV\,(X)_{20\%} &= 31{,}000(1.20)^3 + 40{,}000(1.20)^2 + 50{,}000(1.20) + 70{,}000 \\
&= \text{Rs } 241{,}168 \\
TV\,(Y)_{14\%} &= 71{,}000(1.14)^3 + 40{,}000(1.14)^2 + 40{,}000(1.14) + 20{,}000 \\
&= \text{Rs } 223{,}911 \\
TV\,(Y)_{20\%} &= 71{,}000(1.20)^3 + 41{,}000(1.20)^3 + 40{,}000(1.20) + 20{,}000 \\
& \text{Rs } 249{,}488
\end{aligned}$$

Step 2 The NPV^* of projects *X* and *Y* for the two re-investment rates are:

$$NPV^*\ (X)_{14\%} = \frac{TV\,(X)_{14\%}}{(1.10)^4} - 110{,}000$$

$$= \text{Rs } 43{,}614$$

$$NPV^*\ (X)_{20\%} = \frac{TV\,(X)_{20\%}}{(1.10)^4} - 110{,}000$$

$$= \text{Rs } 54{,}717$$

$$NPV^*\ (Y)_{14\%} = \frac{TV\,(Y)_{14\%}}{(1.10)^4} - 110{,}000$$

$$= \text{Rs } 42{,}931$$

$$NPV^*\ (Y)_{20\%} = \frac{TV\,(Y)_{20\%}}{(1.10)^4} - 110{,}000$$

$$= \text{Rs } 60{,}400$$

Determining the Capital Budget Under Conditions of Increasing Marginal Cost of Capital

When the marginal cost of capital is constant, the optimal capital budget consists of all projects which have a positive net present value at the given marginal cost of capital. However, when the marginal cost of capital increases at discrete points as more and more financing is sought, determination of the optimal capital budget is not easy. While a precise solution to this problem can be a bit involved, a reasonably satisfactory solution can be reached as follows:

1. Determine the set of projects that has the highest net present value for each level of financing before a break in the marginal cost of capital schedule.
2. Choose the level of financing and the corresponding set of investment projects which has the highest net present value.

To illustrate the above procedure consider an example. The Deodhar Corporation has estimated that its marginal cost of capital schedule is as follows:

Level of financing (Rs in million)	Marginal cost of capital %
50	11
100	12
150	13
200	14

The firm first identifies a set of investment projects which generate the highest net present value given a capital budget constraint of Rs 50 million and a discount rate of 11 per cent; it then identifies a set of investment projects which generate the highest net present value given a capital budget constraint of Rs 100 million and a discount rate of 12 per cent; so on and so forth. The net present value of investment projects identified at various levels of financing (and investment) is given below:

Level of financing and investment (Rs in million)	Net present value of chosen set (Rs in million)
50	20
100	35
150	45
200	42

The highest net present value occurs when the firm invests Rs 150 million. So this represents the optimal capital budget.

Evaluation

Conceptually sound, the net present value criterion has considerable merits:

- It takes into account the time value of money.
- It considers the cash flow stream in its entirety.
- It squares neatly with the financial objective of maximisation of the wealth of shareholders. The net present value represents the contribution to the wealth of shareholders.
- The net present value of various projects, measured as they are in today's rupees, can be added. For example, the net present value of a package consisting of two projects, *A* and *B*, will simply be the sum of the net present value of these projects individually:

$$NPV(A+B) = NPV(A) + NPV(B) \tag{10.4}$$

The additivity property of net present value ensures that a poor project (one which has a negative net present value) will not be accepted just because it is combined with a good project (which has a positive net present value).

Given the above merits, the net present value criterion is conceptually unassailable. Its practical application; however, seems to be marred by the following.

- The ranking of projects on the net present value dimension is influenced by the discount rate. To illustrate, consider two mutually exclusive projects, *A* and *B*, which have the following cash flow streams:

Year	A	B
0	– 300,000	– 300,000
1	60,000	130,000
2	100,000	100,000
3	120,000	80,000
4	150,000	60,000

The net present value of *A* and *B* for various rates of discount is given below. It is also shown graphically in Exhibit 10.1.

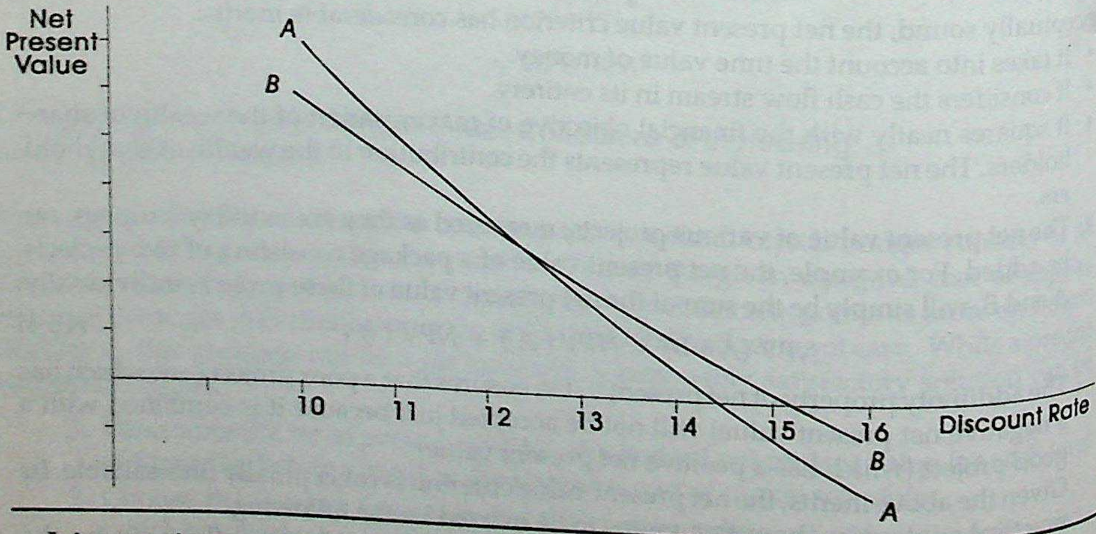
Discount rate	*NPV* (A)	*NPV* (B)
10%	36,622	29,180
12%	20,390	17,658
14%	5,318	6,828
15%	– 1,826	1,654
16%	– 8,702	– 3,350

Looking at the behaviour of net present value, we find that: (i) when the discount rate is 12 per cent, the net present value of *A* is greater than the net present value of *B*; (ii) when the discount rate is 14 per cent the net present value of *B* is greater than the net present value of *A*.

- The net present value measure, an absolute measure, does not appear very meaningful to businessmen who are wonted to think in terms of rate of return measures.

EXHIBIT 10.1

Net Present Value of *A* and *B* for Various Discount Rates



It is sometimes argued that the sensitivity of *NPV* to changes in the discount rate and the absolute nature of *NPV* represent real shortcomings, limiting its use in practice. This is an erroneous view reflecting an inadequate grasp of what a good appraisal criterion should be.

If the conceptual foundation of *NPV* is properly understood by the practitioners, they will regard the above as positive, rather than negative, features of *NPV*.

BENEFIT-COST RATIO

There are two ways of defining the benefit-cost ratio. The first definition relates the present value of benefits to the initial investment.

$$BCR = \frac{PVB}{I} \tag{10.5}$$

where BCR = benefit-cost ratio[3]
PVB = present value of benefits
I = initial investment

The second measure, a net measure, relates net present value to initial investment.

$$NBCR = \frac{NPV}{I} = \frac{PVB - I}{I} = \frac{PVB}{I} - 1 \tag{10.6}$$

where $NCBR$ = net benefit-cost ratio
NPV = net present value
PVB = present value of benefits
I = initial investment

To illustrate the calculation of these measures, let us consider a project which is being evaluated by a firm that has a cost of capital of 12 per cent.

Initial investment : Rs 1,00,000	
Benefits:	
Year 1	25,000
Year 2	40,000
Year 3	40,000
Year 4	50,000

The benefit-cost ratio measures for this project are:

$$BCR = \frac{\dfrac{25{,}000}{(1.12)} + \dfrac{40{,}000}{(1.12)^2} + \dfrac{40{,}000}{(1.12)^3} + \dfrac{50{,}000}{(1.12)^4}}{1{,}00{,}000} = 1.145$$

and $NBCR = BCR - 1 = 0.145$

The two benefit-cost ratio measures give the same signals because the difference between them is simply unity. The following decision rules are associated with them.

When BCR or NBCR		Rule is
> 1	> 0	Accept
$= 1$	$= 0$	Indifferent
< 1	< 0	Reject

Evaluation

The proponents of benefit-cost ratio argue that since this criterion measures net present value per rupee of outlay, it can discriminate better between large and small investments and hence is preferable to the net present value criterion.

How valid is this argument? Weingartner[2], who examined this criterion theoretically, finds that: (i) Under unconstrained conditions, the benefit-cost ratio criterion will accept and reject the same projects as the net present value criterion. (ii) When the capital budget is limited in the current period, the benefit-cost ratio criterion may rank projects correctly in the order of decreasingly efficient use of capital. However, its use is not recommended because it provides no means for aggregating several smaller projects into a package that can be compared with a large project. (iii) When cash outflows occur beyond the current period, the benefit-cost ratio criterion is unsuitable as a selection criterion.

INTERNAL RATE OF RETURN

The internal rate of return of a project is the discount rate which makes its net present value equal to zero. It is the discount rate in the equation:

$$0 = \frac{CF_0}{(1+r)^0} + \frac{CF_1}{(1+r)^1} + \ldots + \frac{CF_n}{(1+r)^n} = \sum_{t=0}^{n} \frac{CF_t}{(1+r)^t} \tag{10.7}$$

where CF_t = cash flow at the end of year t
r = discount rate
n = life of the project

In the net present value calculation, we assume that the discount rate (cost of capital) is known and determines the net present value of the project. In the internal rate of return calculation, we set the net present value equal to zero and determine the discount rate (internal rate of return) which satisfies this condition.

To illustrate the calculation of internal rate of return, consider the cash flows of a project:

Year	Cash flow
0	–100,000
1	30,000
2	30,000
3	40,000
4	45,000

The internal rate of return is the value of r which satisfies the following equation.[3]

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[2] H.M. Weingartner, "The Excess Present Value Index —A Theoretical Basis and Critique", *Journal of Accounting Research*, Vol.1 (Autumn 1963), 213-24.

[3] This equation is simply another way of putting

$$0 = \frac{-100{,}000}{(1+r)^0} + \frac{30{,}000}{(1+r)^1} + \frac{30{,}000}{(1+r)^2} + \frac{40{,}000}{(1+r)^3} + \frac{45{,}000}{(1+r)^4}$$

$$100{,}000 = \frac{30{,}000}{(1+r)} + \frac{30{,}000}{(1+r)^2} + \frac{40{,}000}{(1+r)^3} + \frac{45{,}000}{(1+r)^4}$$

The calculation of r consists of a process of trial and error. We try different values of r till we find that the right-hand side of the above equation is equal to 100,000. Let us, to begin with, try $r = 12$ per cent. The right-hand side of the above equation becomes:

$$\frac{30{,}000}{(1.12)} + \frac{30{,}000}{(1.12)^2} + \frac{40{,}000}{(1.12)^3} + \frac{45{,}000}{(1.12)^4} = 107{,}773$$

Since this is more than 100,000, we have to try a higher value of r. (In general, a higher r lowers the right-hand side value and a lower r increases the right-hand side value.) Let us try $r = 14$ per cent. This makes the right-hand side equal to:

$$\frac{30{,}000}{(1.14)} + \frac{30{,}000}{(1.14)^2} + \frac{40{,}000}{(1.14)^3} + \frac{45{,}000}{(1.14)^4} = 103{,}046$$

Since this value is higher than the target value of 100,000, we have to try a still higher value of r. Let us try $r = 15$ per cent. This makes the right-hand side equal to:

$$\frac{30{,}000}{(1.15)} + \frac{30{,}000}{(1.15)^2} + \frac{40{,}000}{(1.15)^3} + \frac{45{,}000}{(1.15)^4} = 100{,}802$$

This value is a shade higher than our target value, 100,000. So we increase the value of r from 15 per cent to 16 per cent. The right-hand side becomes:

$$\frac{30{,}000}{(1.16)} + \frac{30{,}000}{(1.16)^2} + \frac{40{,}000}{(1.16)^3} + \frac{45{,}000}{(1.16)^4} = 98{,}641$$

Since this value is now less than 100,000, we conclude that the value of r lies between 15 per cent and 16 per cent. For most of the purposes this information suffices.

However, if a single value is required, we have to resort to interpolation.

At 15 per cent, the present value is Rs 100,802

At ? per cent, the present value is Rs 100,000

At 16 per cent, the present value is Rs 98,641

1 per cent difference (between 15 per cent and 16 per cent) corresponds to a difference of Rs 2,161. The difference between Rs 100,802 (present value at 15 per cent) and Rs 100,000 (target present value) is Rs 802. This difference will correspond to a percentage difference of:

$$\frac{802}{2161} \times 1 = 0.37 \text{ per cent}$$

Adding this number to 15 per cent, we get the interpolated value as 15.37 per cent.

The Starting Point The above trial and error method can be tedious. In order to reduce the tedium, some way may be found to get a starting discount rate which is fairly close to the internal rate of return. A simple procedure and its application to the above example is described here.

Step 1 Find the average annual cash inflow expected in future. The average annual cash inflow for the above project is:

$$\frac{30{,}000 + 30{,}000 + 40{,}000 + 45{,}000}{4} = \text{Rs } 36{,}250$$

Step 2 Divide the initial outlay by the average annual cash inflow: The initial outlay for the above project is Rs 100,000. When this is divided by Rs 36,350, we get 2.759.

Step 3 Consulting the present value interest factor of annuity (*PVIFA*) table, find the discount rate that will make the present value of an annuity of one rupee (running for a period equal to the life of the project) equal to the figure obtained in step 2. This is the starting discount rate. The discount rate that will make the present value of an annuity of one rupee (running for 4 years) equal to 2.759 is about 16 per cent. This, then, is the starting discount rate in the above example.

What Does IRR Mean?

There are two possible economic interpretations of internal rate of return: (i) The internal rate of return represents the rate of return on the unrecovered investment balance in the project. (ii) The internal rate of return is the rate of return earned on the initial investment made in the project.

To understand the nature of these interpretations, consider a project with the following cash flows.

Year	Cash flow
0	Rs –300,000
1	0
2	417,000
3	117,000

The internal rate of return of this project is the value of r in the expression

$$0 = \frac{-300{,}000}{(1+r)^0} + \frac{0}{(1+r)^1} + \frac{417{,}000}{(1+r)^2} + \frac{117{,}000}{(1+r)^3}$$

The value of r which satisfies the above expression is 30 per cent. This figure, according to the first interpretation of internal rate of return, reflects the rate of return on unrecovered investment balance. The unrecovered investment balance is defined as:

$$F_t = F_{t-1}\,(1+r) + CF_t \qquad (10.8)^4$$

where F_t = unrecovered investment balance at the end of year t
F_{t-1} = unrecovered investment balance at the end of year $t-1$
CF_t = cash flow at the end of year t

Exhibit 10.2 shows that if 30 per cent rate of return is applied on unrecovered investment balance, the balance in the project reduces to 0 at the end of its life.

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[4] Recognising that $F_0 = CF_0$, we may obtain the following by applying the recursive relationship in Eq. (10.8)

$$F_0 = CF_0 \qquad (1)$$

$$F_1 = F_0\,(1+r) + CF_1 = CF_0\,(1+r) + CF_1 \qquad (2)$$

$$F_2 = F_1\,(1+r) + CF_2 = CF_0\,(1+r)^2 + CF_1\,(1+r) + CF_2 \qquad (3)$$

$$\vdots$$

$$F_n = F_{n-1}\,(1+r) + CF_n = CF_0\,(1+r)^n + CF_1\,(1+r)^{n-1} + \ldots + CF_n \qquad (4)$$

EXHIBIT 10.2

Unrecovered Investment Balance

Year	Unrecovered investment balance at the beginning: F_{t-1}	Interest for the year: $F_{t-1}(1+r)$	Cash flow at the end of the year: CF_t	Unrecovered investment balance at the end of the year: $F_{t-1}(1+r)+CF_t$
1	Rs – 300,000	– 90,000	0	– 390,000
2	Rs – 390,000	– 117,000	417,000	– 90,000
3	Rs – 90,000	– 27,000	117,000	0

Now, let us consider the second interpretation according to which, the internal rate of return is the compounded rate of return earned on the initial investment, for the entire life of the project. This means that if a project involves an initial outlay of I, has an internal rate of return of r per cent, and has a life of n years, the value of the benefits of the project, assessed at the end of n years, will be $I(1+r)^n$. In our numerical example, where the initial investment is Rs 300,000, the internal rate of return of the project is 30 per cent, and the life of the project is three years, the value of the benefits of the project, assessed at the end of three years, will be Rs 300,000 $(1 + 0.30)^3$ = Rs 659,100.

The second interpretation of internal rate of return is based on the assumption that the intermediate flows of the project are re-invested at a rate of return equal to the internal rate of return of the project. For our numerical example, it means that the intermediate cash inflow of Rs 4,17,000 occurring at the end of the second year (this is the only intermediate cash inflow for the project) can be re-invested at a rate of return equal to 30 per cent. Given this assumption, we find that the value of all the benefits, assessed at the end of three years, works out to Rs 659,100 as follows:

Year	Benefit (cash inflow)	Compounded value at the end of 3 years
1		-
2	Rs 417,000	542,100
3	Rs 117,000	117,000
	Sum =	659,100

Which economic interpretation should we put on the internal rate of return? Since it is often not possible for a firm to re-invest intermediate inflows at a rate of return equal to the project's internal rate of return, the first interpretation seems more realistic. Hence, we may view internal rate of return as the rate of return on the time-varying, unrecovered investment balance in the project, rather than the compounded rate of return on the initial investment. This point deserves to be underscored because the notion of internal rate of return generally creates the impression that it is the rate of return earned on a sustained basis on the initial investment over the life of the project.

Multiple Rates of Return

The equation of internal rate of return is:

$$\sum_{t=0}^{n} \frac{CF_t}{(1+r)^t} = 0 \tag{10.9}$$

where CF_t = cash flow at the end of year t
r = internal rate of return
n = life of the project

Expanding Eq. (10.9) and multiplying every term in it by $(1+r)^n$, we get:

$$CF_0\ (1+r)^n + CF_1\,(1+r)^{n-1} + \ldots + CF_n = 0 \tag{10.10}$$

This is a polynominal expression of the nth degree in $(1+r)$. If the initial cash flow is an outflow (this means that CF_0 is negative) and the subsequent cash flows are inflows (this means that $CF_1, CF_2, \ldots CF_n$ are all positive), the polynominal expression has only one change in sign. Hence, it has only one real root. If the cash flow stream has multiple changes of sign there may be more than one internal rate of return. Consider a project with the following cash stream:[5]

Year	Cash flow
0	− 1,600
1	+ 10,000
2	− 10,000

The internal rate of return equation for this cash flow stream is:

$$-1{,}600 + \frac{10{,}000}{(1+r)} - \frac{10{,}000}{(1+r)^2} = 0$$

Multiplying this equation by $(1+r)^2$, we get

$$-1{,}600\ (1+r)^2 + 10{,}000\ (1+r) - 10{,}000 = 0$$

This equation has two changes in sign. Hence, it has two real roots. These are 1.25 and 5.00. The internal rates of return corresponding to these roots are 25 per cent and 400 per cent. This is illustrated vividly by the net present value profile of the project shown in Exhibit 10.3. When the discount rate is 0 per cent, the net present value is

$$-1{,}600 + \frac{10{,}000}{(1+r)} - \frac{10{,}000}{(1+r)^2} = 1{,}600$$

As the discount rate rises, the first term, − 1,600, is unaffected, the second term, $\frac{10{,}000}{(1+r)}$, declines, and the third term, $\frac{-10{,}000}{(1+r)^2}$, increases.

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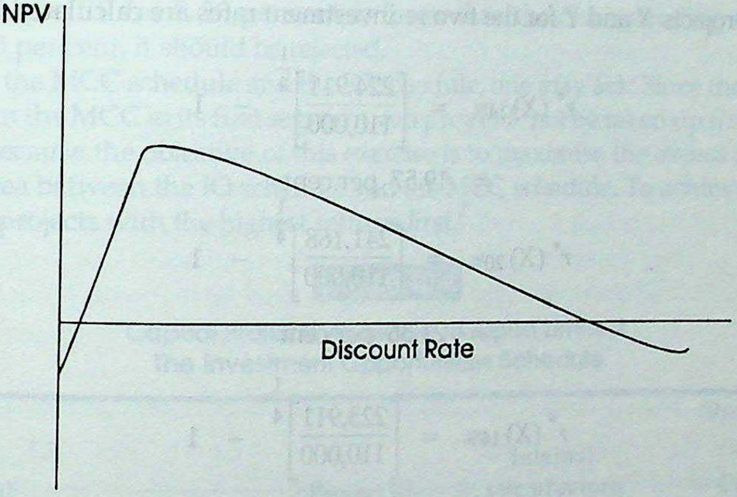
[5] This is the cash flow stream of the famous pump example given by Lorie and Savage. See J.H. Lorie and L.J. Savage, "Three Problems in Capital Rationing", *Journal of Business*, Vol. 28 (October 1955), 229-39.

The increase in the third term is more rapid than the decline in the second term. The effect of these changes is to push the net present value upward. The net present value of the project turns positive when the discount rate exceeds 25 per cent. The net present value continues to increase till the discount rate rises to 100 per cent. Thereafter, the present value of future flows (flows for years 1 and 2) declines in importance in relation to the initial flow of 1,600. As a result of this, the net present value declines. The net present value becomes zero when the discount rate touches 400 per cent and turns negative thereafter.

EXHIBIT 10.3

Net Present Value Profile



Modified Internal Rate of Return

The internal rate of return is generally interpreted as the rate of return earned on a sustained basis on the initial investment over the life of the project. This interpretation is based on the assumption that the intermediate cash inflows of the project can be re-invested at a rate of return equal to the internal rate of return of the project. When this assumption is not valid the re-investment rates applicable to the intermediate cash flows need to be defined for calculating the modified internal rate of return. To do this, the terminal value of the project using the explicitly defined re-investment rate(s) applicable to intermediate cash flows needs to be calculated first. (The procedure for this has been described in the previous section.) Once the terminal value is calculated, the modified internal rate of return is calculated as follows:

$$I\,(1+r^*)^n = TV$$

$$r^* = \left[\frac{TV}{I}\right]^{1/n} \qquad (10.11)$$

where I = initial investment

r^* = modified internal rate of return

n = project life
TV = terminal value

To illustrate the calculation of r^*, revert back to the example on page 232, where the terminal values for projects X and Y were calculated at two re-investment rates, 14 per cent and 20 per cent.

$$TV\,(X)_{14\%} = \text{Rs } 224{,}911$$

$$TV\,(X)_{20\%} = \text{Rs } 241{,}168$$

$$TV\,(X)_{14\%} = \text{Rs } 223{,}911$$

$$TV\,(X)_{20\%} = \text{Rs } 249{,}488$$

The r^* for projects X and Y for the two re-investment rates are calculated below:

$$r^*\,(X)_{14\%} = \left[\frac{224{,}911}{110{,}000}\right]^{\frac{1}{4}} - 1$$

$$= 19.57 \text{ per cent}$$

$$r^*\,(X)_{20\%} = \left[\frac{241{,}168}{110{,}000}\right]^{\frac{1}{4}} - 1$$

$$= 21.36 \text{ per cent}$$

$$r^*\,(X)_{14\%} = \left[\frac{223{,}911}{110{,}000}\right]^{\frac{1}{4}} - 1$$

$$= 19.43 \text{ per cent}$$

$$r^*\,(X)_{20\%} = \left[\frac{249{,}488}{110{,}000}\right]^{\frac{1}{4}} - 1$$

$$= 22.67 \text{ per cent}$$

Investment Opportunity Schedule, Marginal Cost of Capital Schedule, and Optimal Capital Budget

In Chapter 9, we discussed how the marginal cost of capital (MCC) schedule may be developed. We now look at the investment opportunity (IO) schedule and how the same may be combined with the MCC schedule of the firm to determine its optimal capital budget. The IO schedule shows how the internal rate of return behaves as more and more projects are undertaken. To get the IO schedule, the projects submitted for inclusion in the capital budget are ranked in order of their internal rate of return. An illustrative IO schedule is shown in Exhibit 10.4[6]. Using the data in this exhibit, the IO schedule for Alpha Limited may be graphically plotted as shown in Exhibit 10.5. In this exhibit the MCC schedule for Alpha Limited is also plotted. Given these schedules, Alpha Limited should accept five projects, namely, *A*, *B*, *C*, *D*, and *E* , since their internal rates of return exceed the marginal costs of capital for finances required for them. By the same token, projects *G*, *H*, and *I* should be rejected as their internal rates of return are lower than the marginal costs of capital for finances required for them.

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[6] For the sake of simplicity it is assumed that the projects are independent, that the cash inflows are constant, and that there is no capital rationing.

How should project *F* whose IRR line is cut through by the MCC schedule, be evaluated? If it is possible to undertake project *F* partially and invest only Rs 25 million, this should be the preferred course of action. Otherwise, the IRR for project *F* should be compared with the average cost of funds needed to finance it to determine whether it is worthwhile or not. Project *F* would absorb Rs 25 million costing 12.5 per cent and Rs 15 million costing 14.0 per cent. So the average cost of funds needed for it would be 13.0625 per cent ($12.5 \times 5/8 + 14.0 \times 3/8$). Since the IRR for *F*, 13 per cent, is lower than the corresponding average cost of funds, 13.0625 per cent, it should be rejected.

Looking at the MCC schedule and the IO schedule, one may ask: Since the IRR of project *F* is higher than the MCC in its first segment, can project *F* not be taken up first? This should not be done because the objective of this exercise is to maximise the excess of returns over costs or the area between the IO schedule and the MCC schedule. To achieve this objective we start with projects with the highest returns first.[7]

EXHIBIT 10.4

Capital Projects Available to Alpha Limited:
The Investment Opportunities Schedule

(Rs in million)

Project	Initial outlay	Annual inflow	Project life (years)	Internal rate of return (%)	Cumulative investment
A	20	6.169	7	24	20
B	10	2.606	8	20	30
C	15	3.338	10	18	45
D	18	4.885	6	16	63
E	30	5.300	12	14	93
F	40	6.190	15	13	133
G	20	3.754	9	12	163
H	30	4.444	13	11	193
I	15	2.201	12	10	208

Evaluation

Perhaps the most popular discounted cash flow method, the internal rate of return criterion has several virtues.

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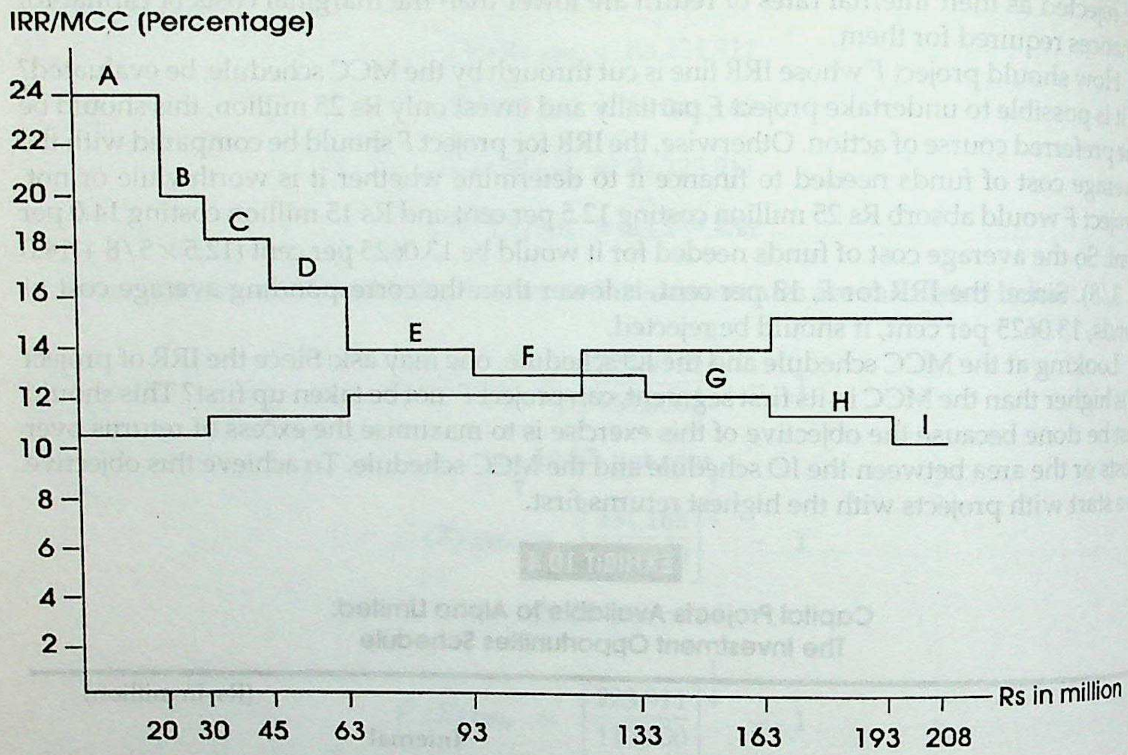
[7] It should, however, be noted that maximisation of the area between the IO schedule and the MCC schedule does not necessarily lead to maximisation of shareholder wealth. In most real life situations, of course, there will be a high degree of congruence between the two.

EXHIBIT 10.5

IO Schedule and MCC Schedule



- It considers the cash flow stream in its entirety.
- It takes into account the time value of money.
- It appeals to businessmen who are wonted to think in terms of rate of return.
- It appears particularly helpful in assessing the margin of safety in a project.
- The ranking of projects on the internal rate of return dimension does not change with variations in the cost of capital.

The internal rate of return criterion, however, has its own limitations.

- It may not be uniquely defined. If the cash flow stream of a project has more than one change in sign, there is a possibility of multiple rates of return.
- The internal rate of return figure cannot distinguish between lending and borrowing and hence a high internal rate of return need not necessarily be a desirable feature. Consider projects *A* and *B*.

	Cash flows	
	0	1
A	– 400	+ 600
B	+ 400	– 700

The internal rate of return for *A* is 50 per cent, whereas the internal rate of return for *B* is 75 per cent. Does this mean that *B* is more attractive than *A*? Certainly not. *A* is a very attractive project whereas *B* is a highly undesirable project. Why? *A* involves investing 400 at a rate of return of 50 per cent whereas *B* involves borrowing 400 at a rate of return of 75 per cent. Yet, if we go by the internal rate of return figures, *B* seems more attractive than *A*.

- The internal rate of return criterion can be misleading when choosing between mutually exclusive projects that have subsantially different outlays. Consider projects *P* and *Q*.

	Cash flows		**Internal rate of return (%)**	**Net present value (assuming $k = 12$ per cent)**
	0	**1**		
P	– 10,000	+ 20,000	100	7,857
Q	– 50,000	+ 75,000	50	16,964

Both the projects are good, but *Q*, with its higher net present value, contributes more to the wealth of the shareholders. Yet from an internal rate of return point of view *P* looks better than *Q*. Hence the internal rate of return criterion seems unsuitable for ranking projects of different scale.[8]

- The argument that the internal rate of return criterion is better than the net present value criterion, as its results are initially independent of the cost of capital figure, seems misplaced. Why should the cost of capital be singled out as an estimate that need not be used in the basic calculation? More so when the error in estimating the cost of capital tends to be lower than the error in estimating other variables (revenues, costs, project life, and so on) in an investment decision. Ranking of projects should be responsive to, and not invariant to, changes in the cost of capital.

URGENCY

According to this criterion projects that are deemed to be more urgent get priority over projects that are regarded as less urgent.

The problem with this criterion is: How can the degree of urgency be determined? In certain situations, of course, it may not be difficult to identify really urgent investments. For example, some minor equipment that has failed may have to be replaced immediately to ensure continuity of production. Non-replacement of such equipment may mean considerable losses arising from stoppage in production. It may be futile in such a case to go into detailed analysis and delay decision.

In many situations, however, it is difficult to determine the relative degree of urgency because of the lack of an objective basis. The use of urgency criterion may imply that the persuasiveness of those who propose projects would become a very important factor in investment decisions. Resource allocation may degenerate into a political battle.

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[8] The internal rate of return criterion, of course, can be salvaged in such cases by considering the internal rate of return on the incremental flows. Here is how we do it. Looking at *P*, the project which requires the smaller outlay, we find that it is highly attractive because its internal rate of return is 100 per cent. Now we ask: What is the rate of return on the incremental cash flows if we switch from *P* (the low-outlay project) to *Q* (the high-outlay project)? The incremental flows from such a switch are:

0	1
– 40,000	+ 55,000

The internal rate of return on these flows is 37.5 per cent, much above the cost of capital. Hence it is desirable to switch from *P* to *Q*.

In view of these limitations of the urgency criterion, we suggest that in general it should not be used for investment decision making. In exceptional cases, where genuine urgency exists, it may be used provided investment outlays are not large.

PAYBACK PERIOD

The payback period is the length of time required to recover the initial cash outlay on the project. For example, if a project involves a cash outlay of Rs 600,000 and generates cash inflows of Rs 100,000, Rs 150,000, Rs 150,000, and Rs 200,000 in the first, second, third, and fourth years respectively, its payback period is four years because the sum of cash inflows during four years is equal to the initial outlay. When the annual cash inflow is a constant sum, the payback period is simply the initial outlay divided by the annual cash inflow. For example, a project which has an initial cash outlay of Rs 1,000,000 and a constant annual cash inflow of Rs 300,000 has a payback period of Rs 1,000,000/Rs 300,000 = 3 1/3 years.

According to the payback criterion, the shorter the payback period, the more desirable the project. A firm using this criterion, may specify the maximum acceptable payback period. If this is *n* years, projects with a payback period of *n* years or less are deemed worthwhile, and projects with a payback period exceeding *n* years are considered unworthy. More commonly, however, the payback period may be used as a constraint rather than as the decision criterion.

Evaluation

A widely used appraisal criterion, the payback period seems to offer the following advantages.

- It is simple, both in concept and application. It does not use involved concepts and tedious calculations and has few hidden assumptions.
- It is a rough and ready method for dealing with risk. It favours projects which generate substantial cash inflows in earlier years and discriminates against projects which bring substantial cash inflows in later years but not in earlier years. Now, if risk tends to increase with futurity—in general, this may be true—the payback criterion may be helpful in weeding out risky projects. Similarly, it serves well for projects characterised by a high degree of cataclysmic risks.
- Since it emphasises earlier cash inflows, it may be a sensible criterion when the firm is pressed with problems of liquidity or during periods when financing costs are very high.
- The payback period suffers from several limitations.
- It ignores the time value of money. Cash inflows, in the payback calculation, are simply added without suitable discounting. This violates the most basic principle of financial analysis which stipulates that cash flows occurring at different points of time can be added or subtracted only after suitable compounding/discounting.
- It overlooks cash flows beyond the payback period. This leads to discrimination against projects which generate substantial cash inflows in later years. To illustrate, consider the cash flows of two projects, *A* and *B*.

Year	Cash flow of A	Cash flow of B
0	– 100,000	– 100,000
1	50,000	20,000
2	30,000	20,000
3	20,000	20,000
4	10,000	40,000
5	10,000	50,000
6		60,000

The payback criterion prefers *A*, which has a payback period of 3 years, in comparison to *B*, which has a payback period of 4 years, even though *B* has very substantial cash inflows in years 5 and 6.

- Since the payback period is a measure of a project's capital recovery, it may divert attention from profitability. Merrett and Sykes note that: "It (payback) has harshly, but not unfairly, been described as the 'fish bait' test since effectively it concentrates on the recovery of the bait (the capital outlay) paying no attention to the size of the fish (the ultimate profitability), if any."[9]
- Though it measures a project's liquidity, it does not indicate the liquidity position of the firm as a whole, which is more important. Weingartner writes: "The usually designated speculative and/or precautionary motive of firms to hold liquid or near liquid funds in order to seize upon unexpected opportunities is a different motive from that which requires each new investment separately to recover its original cost within a short time".[10]
- The argument that the payback method can deal with risk may not be very tenable. The payback method, in effect, assigns a zero weight to cash flows beyond the payback period. Business risks are not so catastrophic to warrant such a treatment.

Discounted Payback Period

A major shortcoming of the conventional payback period method is that it does not take into account the time value of money. To overcome this limitation, the discounted payback period method has been suggested. In this modified method, cash flows are first converted into their present values (by applying suitable discounting factors) and then added to ascertain the period of time required to recover the initial outlay on the project. Exhibit 10.6 illustrates the calculation of discounted payback period. Looking at the last column in this exhibit, we find that the discounted payback period is between 3 and 4 years.

Why is Payback Period Commonly Employed?

Despite its serious shortcomings the payback period is widely used in appraising investments. Why? It appears that the payback measure serves as a proxy for certain types of information which are useful in investment decision making.

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[9] Merrett, A.J. and A. Sykes, *The Finance and Analysis of Capital Projects*, London: Longmans Green and Co. Ltd., 1963.

[10] Weingartner, H.M. "Some Views on the Payback Period and Capital Budgeting Decisions," *Management Science*, vol. 15, August 1969.

EXHIBIT 10.6

Calculation of Discounted Payback Period

Year	Cash flow	Discounting factor @ 10%	Present value	Cumulative net cash flow after discounting
0	– 10,000	1.000	– 10,000	– 10,000
1	3,000	0.909	2,727	– 7,273
2	3,000	0.826	2,478	– 4,795
3	4,000	0.751	3,004	– 1,791
4	4,000	0.683	2,732	941
5	5,000	0.621	3,105	
6	2,000	0.565	1,130	
7	3,000	0.513	1,539	

1. The payback period may be regarded roughly as the reciprocal for the internal rate of return when the annual cash inflow is constant and the life of the project fairly long.[11]
2. The payback period is somewhat akin to the break-even point. A rule of thumb, it serves as a useful shortcut in the process of information generation and evaluation.
3. The payback period conveys information about the rate at which the uncertainty associated with a project is resolved. The shorter the payback period, the faster the uncertainty associated with the project is resolved. The longer the payback period, the slower the uncertainty associated with the project is resolved. Decision makers, it may be noted, prefer an early resolution of uncertainty. Why? An early resolution of uncertainty enables the decision maker to take prompt corrective action, adjust his consumption patterns, and modify/change other investment decisions.

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[11] The following analysis bears this out.

Let I = initial outlay
C = constant annual cash inflow
S = salvage value
and n = life of the project

The internal rate of return is the value of r in the equation:

$$I = \sum_{t=1}^{n} \frac{C}{(1+r)^t} + \frac{S}{(1+r)^n} \quad (1)$$

Since

$$\sum_{t=1}^{n} \frac{C}{(1+r)^t} = \frac{C}{r} - \frac{C}{r}\left[\frac{1}{(1+r)}\right]^n \quad (2)$$

the internal rate of return equation becomes

$$I = \frac{C}{r} - \frac{C}{r}\left[\frac{1}{(1+r)}\right]^n + \frac{S}{(1+r)^n} \quad (3)$$

When n is very large, the last two terms on the right-hand side of the above expression become negligible. Hence

$$I \cong \frac{C}{r} \quad (4)$$

This means

$$r \cong \frac{C}{I} \quad (5)$$

In words, the internal rate of return is approximately the inverse of the payback period.

ACCOUNTING RATE OF RETURN

The accounting rate of return, also referred to as the average rate of return or the return on investment, is a measure of profitability which relates income to investment, both measured in accounting terms. Since income and investment can be measured variously, there can be a very large number of measures for accounting rate of return.[12]

The measures that are employed commonly in practice are:

A: $$\frac{\text{Average income after tax}}{\text{Initial investment}}$$

B: $$\frac{\text{Average income after tax}}{\text{Average investment}}$$

C: $$\frac{\text{Average income after tax but before interest}}{\text{Initial investment}}$$

D: $$\frac{\text{Average income after tax but before interest}}{\text{Average investment}}$$

E: $$\frac{\text{Average income before interest and taxes}}{\text{Initial investment}}$$

F: $$\frac{\text{Average income before interest and taxes}}{\text{Average investment}}$$

G: $$\frac{\begin{array}{l}\text{Total income after tax} - \text{Initial investment}\\ \text{but before depreciation}\end{array}}{\dfrac{\text{Initial investment}}{2} \times \text{years}}$$

The computation of various measures of accounting rate of return is shown in Exhibit 10.7 with reference to a hypothetical project.

Obviously, the higher the accounting rate of return, the better the project. In general, projects which have an accounting rate of return equal to or greater than a pre-specified cut off rate of return—which is usually between 15 per cent and 30 per cent—are accepted; others are rejected.

Accounting Rate of Return and Internal Rate of Return

It is very difficult to generalise if the accounting rate of return is calculated on the basis of average income over the life of the project. However, if the accounting rate of return is calculated for each year using the expected (or actual) net income, the following generalisations may be made:

- The accounting rate of return tends to understate the internal rate of return for earlier years and overstate it for later years.

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[12] According to Moustafa H. Abdelsamad, there are 864 possible measures of accounting rate of return, based on 24 ways of computing income and 36 ways of defining investment. See Moustafa H. Abdelsamad, *A Guide to Capital Expenditure of Analysis*, AMACOM, New York, 1973, p. 50.

EXHIBIT 10. 7

Various Measures of Accounting Rate of Return

(Rs in million)

Year	Investment (book value)	Depreciation	Income before interest and taxes	Interest	Income before tax	Tax	Income after tax
1	1.00	0.20	0.30	0.10	0.20	0.100	0.100
2	0.80	0.20	0.35	0.10	0.25	0.125	0.125
3	0.60	0.20	0.40	0.10	0.30	0.150	0.150
4	0.40	0.20	0.40	0.10	0.30	0.150	0.150
5	0.20	0.20	0.35	0.10	0.25	0.125	0.125
Sum:	3.00	1.00	1.80	0.50	1.30	0.650	0.650
Average	0.60	0.20	0.36	0.10	0.26	0.130	0.130

Measures

A: $$\frac{\text{Average income after tax}}{\text{Initial investment}} = \frac{0.13}{1.00} = 13.0\%$$

B: $$\frac{\text{Average income after tax}}{\text{Average investment}} = \frac{0.13}{0.60} = 21.7\%$$

C: $$\frac{\text{Average income after tax but before interest}}{\text{Initial investment}} = \frac{0.13 + 0.10}{1.0} = 23.0\%$$

D: $$\frac{\text{Average income after tax but before interest}}{\text{Average investment}} = \frac{0.13 + 0.10}{0.60} = 38.3\%$$

E: $$\frac{\text{Average income before interest and taxes}}{\text{Initial investment}} = \frac{0.36}{1.0} = 36\%$$

F: $$\frac{\text{Average income before interest and taxes}}{\text{Average investment}} = \frac{0.36}{0.60} = 60.0\%$$

G: $$\frac{\text{Total income after tax but before depreciation} - \text{Initial investment}}{\dfrac{\text{Initial investment}}{2} \times \text{Years}} = \frac{0.65 + 1.00 - 1.00}{\frac{1}{2} \times 5} = 26.0\%$$

- The accounting rate of return and the internal rate of return can be the same only if the depreciation schedule is equal to the economic depreciation schedule.
- Inflation and creative accounting tend to create a discrepancy between the accounting rate of return and the internal rate of return.

Evaluation

Traditionally a popular investment appraisal criterion, the accounting rate of return has the following virtues:

- It is simple to calculate.
- It is based on accounting information which is readily available and familiar to businessmen.
- It considers benefits over the entire life of the project.
- Since it is based on accounting measures, which can be readily obtained from the financial accounting system of the firm, it facilitates post-auditing of capital expenditures.
- While income data for the entire life of the project is normally required for calculating the accounting rate of return, one can make do even if complete income data is not available. For example, when due to indeterminacy of project life a complete forecast of income cannot be obtained, the accounting rate of return may be calculated on the basis of income for some typical year or income for the first three to five years.

The shortcomings of the accounting rate of return criterion seem to be considerable:

- It is based upon accounting profit, not cash flow.
- It does not take into account the time value of money. To illustrate this point, consider two investment proposals *X* and *Y*, each requiring an outlay of Rs 100,000. Both the proposals have an expected life of four years after which their value would be nil. Relevant details of these proposals are given below:

	X				Y			
Year	Book value	Deprecia-tion	Profit after tax	Cash flow	Book value	Deprecia-tion	Profit after tax	Cash flow
0	100,000	0	0	(100,000)	100,000	0	0	(100,000)
1	75,000	25,000	40,000	65,000	75,000	25,000	10,000	35,000
2	50,000	25,000	30,000	55,000	50,000	25,000	20,000	45,000
3	25,000	25,000	20,000	45,000	25,000	25,000	30,000	55,000
4	0	25,000	10,000	35,000	0	25,000	40,000	65,000

Both the proposals, with an accounting rate of return (measure *A*) of 50 per cent, look alike from the accounting rate of return point of view, though project *X*, because it provides benefits earlier, is much more desirable. While the payback period criterion gives no weight to more distant benefits, the accounting rate of return criterion seems to give them too much weight.

- There are, as we have seen, numerous measures of accounting rate of return. This can create controversy, confusion, and problems in interpretation.
- Accounting income (whatever particular measure of income we choose) is not uniquely defined because it is influenced by the methods of depreciation, inventory valuation, and allocation of certain costs. Working with the same basic accounting data, different accountants are likely to produce different income figures. A similar problem, though less severe, exists with respect to investment.

- The argument that the accounting rate of return measure facilitates post-auditing of capital expenditure is not very valid. The financial accounting system of a firm is designed to report events with respect to accounting periods and for profit centres but not for individual investments.
- The target or hurdle rate of return cannot be specified in relation to the goal of shareholder wealth maximisation.
- The accounting rate of return method can be highly misleading because balance sheet book values reflect neither the earning capacities of assets nor their market values. For example, consider a commercial complex constructed at a cost of Rs 20 million 8 years ago producing presently an income of Rs 1.8 million. While its book value presently is Rs 12 million, its fair market value is Rs 40 million. The return on investment based on the book value works out to 15 per cent (Rs 1.8 million in relation to Rs 12 million). However, if the income is related to the current value, the return on investment is just 4.5 per cent. This example highlights the limitation of using book value figures. It must be stressed that the book value is not relevant as it merely represents sunk costs.

ASSESSMENT OF VARIOUS METHODS

We have discussed at length the five basic methods of evaluation. It may be helpful at this juncture to do a summary assessment of these methods on the basis of certain theoretical and practical considerations. This is done in Exhibit 10.8.

INVESTMENT APPRAISAL : INDIAN PRACTICE

Let us look at investment appraisal in practice in India. Certain questions may be raised in this context:

- How much importance is assigned to economic analysis of capital expenditures in practice?
- What methods are used for analysing capital expenditures in practice and what is the rationale underlying these methods?
- In what ways can economic analysis of capital expenditures be improved in practice?

The answers to these questions are based on a survey conducted by the author.[13] Twenty firms, varying on several dimensions like industry category, size, financial performance, and capital intensity, were included in this survey. In these firms, executives responsible for capital investment evaluation and capital budget preparation were interviewed. The interviews, semi-structured in nature, were conducted to obtain answers to the questions posed above.

Importance of Economic Analysis

The nature of economic analysis of capital expenditures varies from project to project. In a few cases, elaborate analysis is carried out; in most of the cases, however, the analysis is done in sketchy terms. On the whole, one may say that economic analysis is played in a rather low key. The reasons appear to be as follows:

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[13] Prasanna Chandra, "Capital Expenditure Analysis in Practice", *Indian Management*, July 1975.

EXHIBIT 10.8

Assessment of Basic Evaluation Techniques

	Net present value	Benefit cost ratio	Internal rate of return	Payback period	Accounting return of investment
Theoretical considerations					
1. Does the method consider all cash flows?	Yes	Yes	Yes	No	?
2. Does the method discount cash flows at the opportunity cost of funds?	Yes	Yes	No	No	No
3. Does the method satisfy the principle of value additivity?	Yes	No	No	?	?
4. From a set of mutually exclusive projects, does the method choose the project which maximises shareholder wealth?	Yes	No	No	?	?
Practical considerations					
1. Is the method simple?	Yes	Yes	Yes	Yes	Yes
2. Can the method be used with limited information?	No	No	No	Perhaps	Yes
3. Does the method give a relative measure?	No	Yes	Yes	No	Yes

(a) Most of the proposals are meant either for the replacement of some worn out equipment forming part of a production complex or for adding capacity at some stage of production to ensure better balancing of capacities at various stages. In these cases, it is difficult to evaluate independently the economics of proposed investments. They are usually labelled 'urgent' or 'necessary' and this prejudgement precludes further thinking.

(b) Project proposals are reviewed at two or three levels (in one organisation as many as five levels of review was obtained, but this is an exceptional case) before a final decision, and the judgement of the reviewing authorities is regarded more important than detailed analysis.

(c) It is difficult to estimate accurately the costs and revenues associated with capital investments. The range of error in these estimates, it is argued, does not justify sophisticated analysis.

(d) In many cases only one type of equipment or machinery satisfied the specific requirements. In the absence of alternatives that can be compared, detailed analysis seems to be unwarranted.

Methods of Appraisal and Their Rationale

1. A wide variety of measures are used for evaluating investments. These include measures suggested by capital budgeting literature and several non-standard measures.
2. The most commonly used method for evaluating investments of a small size is the payback method. The following reasons have been given by managers employing this method.

> We don't have ample funds. Most of the components of our compressor are made outside. We take up only those components which have a payback period of three years or less so that our limited funds are not locked up for long.
>
> We follow the payback period method because the shorter the payback period the higher the return.
>
> Since returns are not assured it is safer to put money in a line where it is quickly recovered

3. For investments of large size the average rate of return is commonly used as the principal criterion and the payback period is used as a supplementary criterion. In support of the average rate of return method, one executive said:

> Our aim is to increase profitability. Profits in relation to investment is the average rate of return. This figure tells me whether the project is good. This can be compared with the cost of money.

Another executive, who appeared familiar with discounted cash flow techniques but who used the average rate of return method, argued as follows:

> The discounted cash flow method calls for estimates of costs and revenues over the whole project life. This is difficult. Very often we can't estimate the life. We have been using machines longer than their life by good maintenance. Changes in cost and revenues also cannot be predicted. Due to these difficulties we use the accounting rate of return method. Here we take our best estimates for 2–3 years and calculate the average return. Once the project is established the balance between cost and revenue can be maintained in normal circumstances.

4. Discounted cash flow (DCF) techniques, though not commonly used, are gaining in importance, particularly in the evaluation of large investments. In one company where informal appraisals are used for smaller outlays, DCF analysis is being used for all independent projects which generally involve substantial outlays. The rationale of this practice was explained by one manager.

> It is not possible to know the yield of an investment in a machine or process independently. Nor is it worthwhile to know because sponsors of such projects provide suitable justification—better quality, fewer breakdowns, etc. Yield calculations are made for independent units. They are needed for proper appraisal.

5. Several other criteria are used for evaluating investments: profit per rupee invested, cost saving per unit of product, investment required to replace a worker. It appears that these criteria are more intelligible to operations-minded managers. Although in some cases these criteria are closely related to measures suggested in theory, it is difficult to make generalisations about their suitability. The variety of

measures used by project sponsors seem to create problems of understanding and comparison for the higher executives.

6. Although specific measures of investment worth are calculated, only four firms, out of the sample of 20 firms studied, seemed to have a well-defined policy about the acceptability of investment projects based on such calculations. By and large, no fixed standards were used for acceptance/rejection of projects. The final decision rested with top management which combined quantitative measures with subjective judgements in an unspecified manner. The difficulty of adhering rigidly to standards was expressed by three managers:

> There are intangible factors, too, which must be considered along with the economics of the project. In view of this, standards cannot be rigidly defined. Moreover, we have to consider our liquidity. If we have sufficient funds we may accommodate more projects. If we do not have money—the problem that we have today—we may not be able to okay otherwise good investments.
>
> Our cost of money has been rising. How can we work with fixed standards?
>
> For replacement investment we have more or less a fixed standard—15 per cent after tax. This is not for few projects. Here we may require 20 per cent or even 25 per cent depending on the circumstances.

7. Limited funds do not appear to be a serious constraint with prosperous firms. A common refrain is: "We will get the funds if we have good projects." Other constraints, more serious than the funds constraint, seem to hinder investment activity. As one manager put it:

> If our investment is slow, it is mainly due to governmental delays in approving the proposed collaboration—not for want of money.

The situation with less prosperous concerns is different. Limited funds often pose a serious bottleneck with firms which have poor financial resources. In these firms investments are made only when they are unavoidable. In other words, they adopt the criterion of 'non-postponability', to use a term suggested by one manager.

Room for Improvement

On the basis of the foregoing, we make the following suggestions for improving capital budgeting in practice.

1. As far as possible the criteria of investment evaluation should be standardised. The use of many measures makes comparison difficult.
2. The concepts used in analysis must be clearly defined. Vague, qualitative phrases should be substituted by quantitative measures wherever possible. This is necessary to promote understanding and dispel confusion.
3. The characteristics of various methods must be properly understood. Wrong notions like "the inverse of payback is equal to the rate of return" and "net present value and yield are alike" must be corrected.
4. Discounted cash flow techniques should receive greater emphasis. They are theoretically superior and practically feasible. The use of these techniques compels a firm to 'look ahead' which in itself has a significant payoff. This advantage, however, can be enjoyed only if the 'look ahead' is done carefully and realistically. If it is done in a very mechanical fashion then no advantage is likely to accrue.

The argument of some executives that discounted cash flow techniques require difficult-to-obtain information and that many persons are not familiar with them, reflects inertia and a non-progressive outlook. Determined efforts to introduce discounted cash flow techniques can overcome these hurdles.

In sum, evaluation must be carried out in explicit, well-defined, preferably standardised terms and should be based on sound economic logic. Informal and cursory treatment should give way to thorough and rigorous analysis. It must be realised that the prerogative of investment decision-making has a concomitant responsibility—to base such decisions on a careful and sound evaluation.

INVESTMENT APPRAISAL: INTERNATIONAL PRACTICE

While a comprehensive discussion of international practice is beyond the scope of this book (as well as the competence of this author), an inkling of the techniques of evaluation used in the U.S. and Japan, the two largest economies of the world, may be provided here.

Evaluation Techniques in the U.S.

To learn about the methods of evaluation used by business firms in the U.S., we will review the findings of a study conducted by William Petty and David Scott.[14]

The level of importance assigned to the five basic evaluation techniques, viz. accounting return on investment, payback period, net present value, internal rate of return, and profitability index (benefit-cost ratio) is shown in Exhibit 10.9.

EXHIBIT 10.9

Evaluation Techniques

	Level of importance					
Technique	**None**	**Slight**	**Moderate**	**Fair**	**High**	**No response**
Accounting return on investment	12.35%	15.29%	17.06%	8.82%	33.53%	2.94%
Payback period	1.76	12.35	25.29	28.82	30.00	1.76
Net present value	8.82	16.47	20.59	15.29	33.20	5.29
Internal rate of return	7.65	9.41	4.71	14.71	59.41	4.12
Profitability index or benefit-cost ratio	31.17	18.82	15.29	7.65	11.18	15.88

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[14] Though a number of surveys have been conducted in the U.S. from time to time to identify the methods of evaluation used for capital expenditure decisions, we have chosen the study of William Petty and David Scott because it happens to be one of the comprehensive studies which provides very valuable insights. Their study entitled "Capital Budgeting Practices in Large U.S. Firms: A Retrospective Analysis and Update" is reported in the following book: Derkinderen, Frans, G.J., R.L. Crum (eds), *Readings in Strategy of Corporate Investment*, Pitman Publishing Inc., 1981.

Evaluation Techniques in Japan

Japanese firms appear to rely mainly on two kinds of analysis: (a) one year investment analysis and (b) residual investment analysis. While the former needs no explanation, the latter may require some elaboration. The manner in which the residual investment analysis is done is illustrated in Exhibit 10.10. Examining this exhibit we find that the residual investment analysis is similar to the discounted payback analysis. This analysis shows how long will it take for the residual investment in the project to become zero after taking into account the time value of money. This period is conceptually equal to the discounted payback period.

EXHIBIT 10.10

Residual Investment Analysis

Year	Cash flow	Imputed interest @ 10 per cent	Adjusted cash flow	Residual investment
0	(1000)	–	–	–
1	200	100	100	900
2	200	90	110	790
3	300	79	221	569
4	300	57	243	326
5	400	33	367	–
6	400	–	–	–
7	300	–	–	–
8	300	–	–	–

In general, it appears that Japanese firms use methods which are less complicated and sophisticated than the ones used by American firms. Why? Several reasons are offered to explain this difference: (a) Japanese managers, in general, have limited formal business training. (b) There is a great deal of consensus decision making in Japanese firms which necessarily calls for the use of relatively simpler methods. (c) Japanese firms put considerable emphasis on verbal scenario analysis (as opposed to complex calculations) and careful scrutiny of basic assumptions which seems to blend well with a healthy skepticism about the accuracy of quantitative forecasts.

SUMMARY

- A wide variety of appraisal criteria (or evaluation methods) have been suggested to judge the worthwhileness of capital projects. The important and popular of these can be classified into two broad categories: discounting criteria and non-discounting criteria.
- The important discounting criteria are: net present value, benefit-cost ratio, and internal rate of return. The popular non-discounting criteria are: urgency, payback period, and accounting rate of return.
- The net present value of a project is equal to the sum of the present value of all the cash flows (inflows as well as outflows) associated with it. Symbolically

$$NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+k)^t}$$

- The decision rule associated with the net present value is: Accept the project if its net present value is positive and reject it if its net present value is negative.
- The standard net present value method is based on the assumption that the intermediate cash flows are re-invested at a rate of return equal to the cost of capital. When this assumption is not valid, the re-investment rates applicable to the intermediate cash flows need to be defined for calculating the modified net present value.
- When the marginal cost of capital is constant, the optimal capital budget consists of all projects which have a positive net present value at the given marginal cost of capital. However, when the marginal cost of capital increases at discrete points as more and more financing is sought, determination of the optimal capital budget is not easy.
- There are two ways of defining the benefit-cost ratio. The first measure (*BCR*) is:

$$\frac{\text{Present value of benefits}}{\text{Initialinvestment}}$$

The second measure (*NBCR*) is :

$$\frac{\text{Present value of benefits} - \text{Initial investment}}{\text{Initial investment}}$$

- The two benefit cost ratio measures give the same signals because the difference between them is simply unity. The following decision rules are associated with them:

When	*BCR*	or	*NBCR*	Rule is
	> 1		> 0	Accept
	$= 1$		$= 0$	Indifference
	< 1		< 0	Reject

- The internal rate of return of a project is the discount rate which makes its net present value equal to zero. It is the discount rate in the equation:

$$0 = \sum_{t=0}^{n} \frac{CF_t}{(1+r)^t}$$

- There are two possible economic interpretations of internal rate of return: (i) The internal rate of return represents the rate of return on the unrecovered investment balance in the project. (ii) The internal rate of return is the rate of return earned on the initial investment made in the project.
- If the cash flow stream of a project has multiple changes of sign there may be more than one internal rate of return.
- The modified internal rate of return (IRR) is calculated as follows:

$$\text{Modified IRR} = \left[\frac{\text{Terminal value}}{\text{Initial investment}}\right]^{1/n} - 1$$

- According to the urgency criterion, projects that are deemed to be more urgent get priority over projects that are regarded as less urgent. The problem with this criterion is: How can the degree of urgency be determined?

- The payback period is the length of time required to recover the initial cash outlay on the project. According to this criterion, a project is acceptable if the payback period is less than a certain specified payback period.
- A major shortcoming of the conventional payback period method is that it does not take into account the time value of money. To overcome this limitation, the discounted payback period method has been suggested. In this modified method, cash flows are first converted into their present values (by applying suitable discounting factors) and then added to ascertain the period of time required to recover the initial outlay on the project.
- Though the payback period has serious shortcomings, it is widely used because it seems to serve as a proxy for certain types of information useful in investment decision-making.
- The accounting rate of return, also referred to as the average rate of return, is a measure of profitability which relates income to investment, both measured in accounting terms. Since income and investment can be measured variously, there can be a very large number of measures for accounting rate of return. A project is deemed acceptable if its accounting rate of return exceeds a certain cut off rate of return.
- From a theoretical point of view, the net present value method is clearly superior to all other methods.
- A wide variety of measures are used in practice for appraising capital expenditures. These include measures suggested by capital budgeting literature and several non-standard measures.
- For larger projects, accounting rate of return and, in more recent years, discounted cash flow methods are more commonly employed. For smaller projects, the payback period method appears to be popular.
- In the U.S., internal rate of return, net present value, accounting rate of return, and payback period are the most popular methods of project appraisal.
- Japanese firms appear to rely mainly on two kinds of analysis: (i) one year investment analysis and (ii) residual investment analysis.

QUESTIONS

1. How is the net present value defined?
2. What is the rationale for the net present value method?
3. Discuss the features of the net present value method.
4. How is the modified net present value calculated?
5. Discuss a procedure for determining the capital budget under conditions of increasing marginal cost of capital, when the *NPV* criterion is used.
6. Evaluate the *NPV* criterion
7. Define the two measures of benefit-cost ratio.
8. Evaluate the benefit-cost ratio criterion.
9. What is internal rate of return? How is it calculated?
10. Discuss the two possible interpretations of internal rate of return.
11. What is unrecovered investment balance? Illustrate it with an example.
12. Discuss the problem of multiple rates of return.
13. How is the modified internal rate of return calculated?

14. What is investment opportunity schedule?
15. Evaluate the internal rate of return criterion.
16. Critically evaluate the payback period criterion
17. Why is payback period commonly employed?
18. What is discounted payback period?
19. Discuss the various measures that are used to calculate the accounting rate of return.
20. Evaluate the accounting rate of return criterion.
21. Assess various appraisal criteria on the basis of certain theoretical and practical considerations.
22. Comment on investment appraisal practice in India.
23. Describe the evaluation techniques used in the U.S. and Japan.

PROBLEMS

1. Consider two projects, *A* and *B*.

	A	*B*
Investment outlay	100	100
Cash inflows		
year 1	40	70
year 2	50	60
year 3	60	30
year 4	60	20

What is the *NPV** of *A* and *B* when the re-investment rates are 15 per cent and 18 per cent?

2. The cash flow streams for four alternative investments, *A*, *B*, *C*, and *D* are:

Year	A	B	C	D
0	– 200,000	– 300,000	– 210,000	– 320,000
1	+ 40,000	+ 40,000	+ 80,000	+ 200,000
2	+ 40,000	+ 40,000	+ 50,000	+ 20,000
3	+ 40,000	+ 40,000	+ 80,000	–
4	+ 40,000	+ 40,000	+ 60,000	–
5	+ 40,000	+ 40,000	+ 80,000	–
6	+ 40,000	+ 30,000	+ 50,000	–
7	+ 40,000	+ 30,000	+ 40,000	–
8	+ 40,000	+ 20,000	+ 40,000	–
9	+ 40,000	+ 20,000	+ 40,000	+ 200,000
10	+ 40,000	+ 20,000	+ 40,000	+ 50,000

Calculate the payback period, discounted payback period, net present value, internal rate of return, and benefit-cost ratio for the four alternatives. The discount rate is 14 per cent. Which would you choose? Why?

3. What is the internal rate of return of an investment which involves a current outlay of Rs 300,000 and results in an annual cash inflow of Rs 60,000 for seven years?
4. What is the internal rate of return of the following cash flow stream?

Year	Cash flow
0	– 3,000
1	+ 9,000
2	+ 3,000

5. What is the *IRR** of a project which has the following cash flows?

Year	Cash flow
0	– 25,000
1	12,440
2	12,440
3	12,440
4	12,440

The reinvestment rate is 15 per cent.

6. Modern Enterprises Limited is considering the purchase of a computer system which would cost Rs 3.5 million. The operation and maintenance costs (excluding depreciation) per annum are expected to be Rs 0.3 million. The computer system has a useful life of 10 years after which it would have a negligible salvage value. The depreciation rate is 30 per cent (written down value method). The installation of the computer would reduce clerical costs by Rs 0.6 million per year. It will also save space worth Rs 0.1 million per year. The tax rate for the firm is 40 per cent. What is the net present value of the investment?
7. The cash flow stream of a project is given below:

Year	Cash flow
0	Rs – 8,000
1	2,000
2	– 1,000
3	10,000
4	2,000

Calculate the internal rate of return for this project. Define the unrecovered investment balance at the end of each year.

8. The following financial information is available about a project :

(Rs in million)

Year	1	2	3	4	5	6	7	8
Investment	2.40	2.10	1.80	1.50	1.20	0.90	0.60	0.30
Depreciation	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Income before interest and taxes	0.60	0.65	0.70	0.70	0.70	0.65	0.60	0.50
Interest	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Income before tax	0.35	0.40	0.45	0.45	0.45	0.40	0.35	0.25
Tax	–	0.10	0.25	0.25	0.25	0.22	0.19	0.14
Income after tax	0.35	0.30	0.20	0.20	0.20	0.18	0.16	0.11

Compute the various measures of accounting rate of return.

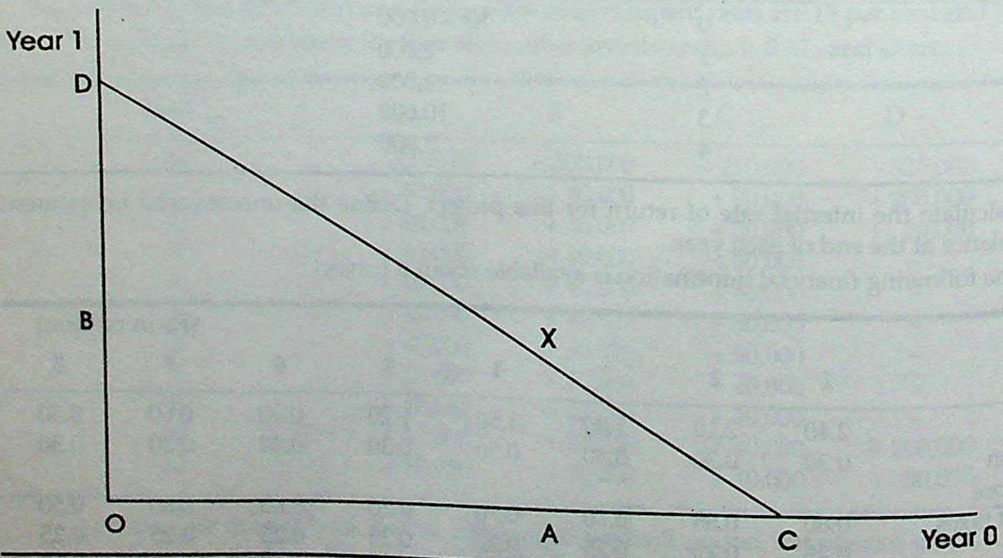
APPENDIX 10A

RATIONALE FOR THE NET PRESENT VALUE CRITERION

The net present value criterion has a sound rationale underlying it. To understand this, let us look at a simple problem concerning a choice between current consumption and future consumption. Suppose you have a cash inflow of *OA* now (year 0) and *OB* in a year from now (year 1) as shown by point X in Exhibit 10A.1. Further assume that through the capital market you can transfer wealth across time by lending or borrowing. The opportunity for lending or borrowing is represented by the line *CXD*. The slope of this line is $(1+r)$, where r denotes the 1-year rate of interest. If you lend your present cash inflow of *OA* at an interest rate of r per cent, your consumption in year 1 will be augmented by $OA\,(1+r)$, which is *BD*. Alternatively, if you borrow against your future inflow, you can augment your current consumption by $OB/(1+r)$ which is equal to *AC*. In general, you can reach any point on the line *CXD*, by lending or borrowing.

EXHIBIT 10A.1

Lending Borrowing Opportunity

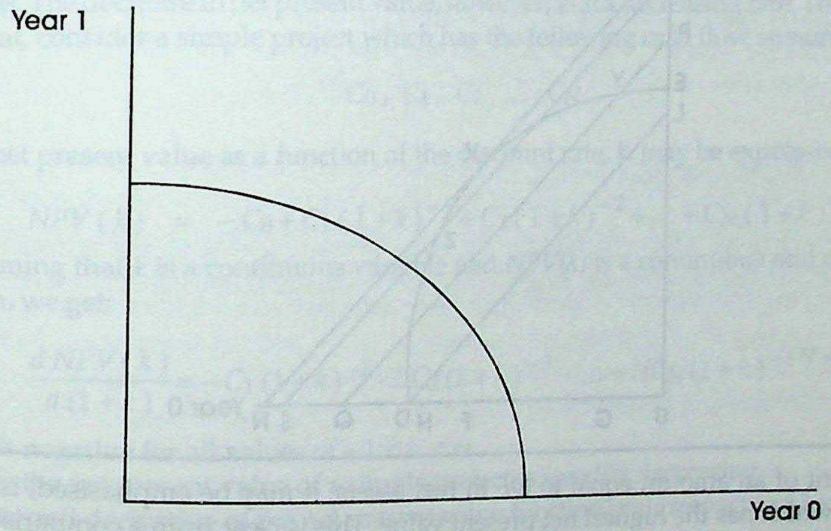


Your investment opportunity, however, is not limited to just lending or borrowing in the capital market. You may also consider investment in land, building, plant, machinery, and other real assets. The investment opportunity line which shows the returns from buying real assets is shown in Exhibit 10A.2. This investment opportunity line, unlike the lending or borrowing line of Exhibit 10A.1, is not a straight line. Its slope is high to begin with but declines progressively because the marginal return from additional investment in real assets tends to decline.

How is your welfare affected by the possibility of investing in real assets along with the possibility of lending or borrowing? To answer this question, we consider the situation illustrated in Exhibit 10A.3 in which we assume, for the sake of simplicity, that your initial resources are equal to *OD*. The opportunity to invest in real assets is represented by the line *DXE* and the lending-borrowing opportunity on the capital market is represented by the straight line *DL*.

EXHIBIT 10A.2

Investment Opportunity Curve



Now let us look at what happens when you invest different amounts in real assets.

- Investment of *DF* in real assets
- Investment of *DG* (an amount greater than *DF*) in real assets
- Investment of *DH* (an amount less than *DF*) in real assets

If you invest *DF* in real assets, a sacrifice of *DF* in year 0 brings a benefit of *FX* in year 1. As a result you move from point *D* to point *X* on the real asset investment opportunity line. From point *X* you can move along the line *MN* by availing of lending-borrowing opportunities. (The line *MN*, it may be noted, is parallel to the line *DL*—all lending-borrowing lines are parallel to each other.)

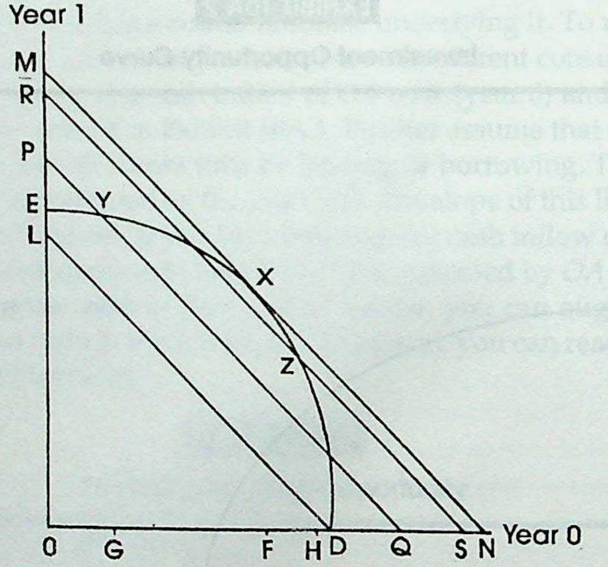
If you invest *DG* in real assets you move from *D* to *Y* on the real asset investment opportunity line. From *Y* you can move along the line *PQ* by availing of lending-borrowing opportunities in the capital market.

If you invest *DH* in real assets you move from *D* to *Z* on the real asset investment opportunity frontier. From *Z* you can move along the line *RS* by availing of lending-borrowing opportunities in the capital market.

What do we find when we compare the three cases? If you invest an amount equal to *DF* in real assets you reach the consumption frontier *MN*; if you invest an amount equal to *DG* in real assets you reach the consumption frontier *PQ*; if you invest an amount equal to *DH* in real assets you reach the consumption frontier *RS*. Clearly, investment of an amount equal to *DF* in real assets is the most desirable course of action since it takes you to the highest consumption frontier.

EXHIBIT 10A.3

Investment and Lending-Borrowing Opportunities



Investment of an amount equal to *DF* in real assets, it may be emphasised, is also the investment which has the highest net present value. This is clear from a comparison of the following:

Net present value of investment DF = Present value of benefits – Present value of costs
$= NF - DF = DN$
Net present value of investment DG = Present value of benefits – Present value of costs
$= QG - DG = DQ$
Net present value of investment DH = Present value of benefits – Present value of costs
$= SH - DH = DS$

Thus, when the net present value is maximised, you reach the highest consumption frontier. This, then, constitutes the rationale for the net present value criterion.

APPENDIX 10B

BEHAVIOUR OF NET PRESENT VALUE FOR A SIMPLE PROJECT

A simple project involves an initial cash outflow (or outflows) followed by subsequent cash inflows. The net present value of a simple project steadily decreases as the discount rate increases. The decrease in net present value, however, is at a decreasing rate. To demonstrate this point, consider a simple project which has the following cash flow stream.

$$C_0,\ C_1,\ C_2,\ldots,C_N$$

The net present value as a function of the discount rate, *k*, may be expressed as:

$$NPV(k) \quad = \quad -C_0+C_1(1+k)^{-1}+C_2(1+k)^{-2}+\ldots+C_N(1+k)^{-N} \qquad (10B.1)$$

Assuming that *k* is a continuous variable and *NPV*(*k*) is a continuous and differentiable function, we get:

$$\frac{d\,NPV(k)}{d\,(1+k)}=-C_1(1+k)^{-2}-2C_2(1+k)^{-3}-\ldots-NC_N(1+k)^{-(N+1)} \qquad (10B.2)$$

This is negative for all values of $-1<k<\infty$.
Hence the net present value of a simple project is steadily decreasing.
The second derivative of the net present value function with respect to $(1+k)$ is :

$$\frac{d\,NPV(k)}{d\,(1+k)^2}=2C_1(1+k)^{-3}+6C_2(1+k)^{-4}-\ldots+N(N+1)\,C_N(1+k)^{-(N+2)} \qquad (10B.3)$$

This is positive for all values of $-1<k<\infty$. Hence the net present value function decreases at a decreasing rate.

APPENDIX 10C

INTERNAL RATE OF RETURN AND RETURN ON INVESTED CAPITAL

Internal rate of return (IRR) is a popular investment criterion. It has great appeal to businessmen who are wonted to think in rate of return terms. However, IRR does not always provide an unambiguous measure of profitability. It is meaningful for certain types of projects, but not for others. Where IRR does not make sense, the criterion of return on invested capital may be employed.

TYPES OF PROJECTS AND RELEVANCE OF IRR

Investment projects may be classified on the basis of two factors: (i) the number of sign changes in the net cash flow stream, and (ii) the form of the unrecovered investment balance stream.

Simple and Non-Simple Investments

As far as the number of sign changes in the net cash flow stream is concerned, a distinction is made between simple and non-simple investments. A simple investment has cash outflow(s) followed by cash inflow(s). There is only one sign change in the cash flow stream. A non-simple investment has one or more cash outflows interspersed with cash inflows. There are at least two sign changes in the cash flow stream. Some illustrations are given below:

	Sign of cash flow at time					
Type of investment	0	1	2	3	4	5
Simple	−	+	+	+	+	+
Simple	−	−	+	+	+	+
Non-simple	−	−	+	+	−	+
Non-simple	−	+	+	−	+	+

Pure and Mixed Investments

On the basis of unrecovered project balance, investments may be divided into two types: pure investments and mixed investments. To clarify the distinction between pure investment and mixed investment, let us recall the definition of unrecovered investment balance.

$$F_t(r) = CF_0(1+r) + CF_1(1+r)^{t-1} + \dots + CF_t \tag{10C.1}$$

where $F_t(r)$ = unrecovered investment balance at the end of year t

CF_0 = cash flow at the end of year 0

CF_t = cash flow at the end of year t

r = internal rate of return

A pure investment is one for which the unrecovered investment balance is either zero or negative throughout the life of the project. In symbols, the investment is pure when the following conditions are satisfied:

$$F_t(r) = \sum_{j=0}^{t} CF_j(1+r)^{t-j} \leq 0 \; (j = 0, 1, \dots, t)\,(t = 0, 1, \dots, N-1) \tag{10C.2}$$

$$F_N(r) = \sum_{j=0}^{N} CF_j(1+r)^{N-j} = 0 \tag{10C.3}$$

In the above two equations N is the life of the project.

Looking at the definition of pure investment, it is clear that a pure investment is one from which the firm does not borrow at any time during the life of the investment but recovers fully its investment at the end of the project life. Hence the internal rate of return of a pure investment represents the rate of return earned on funds invested in the project by the firm.

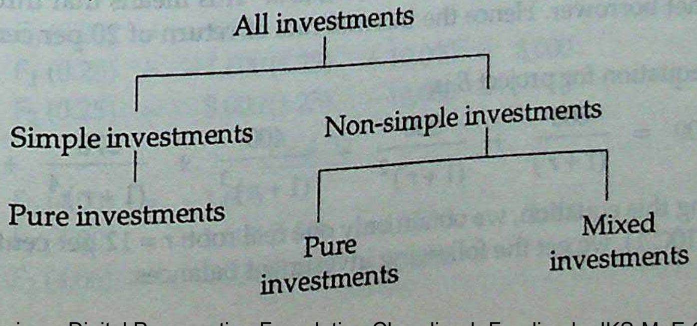
A mixed investment represents an investment for which $F_t(r)$ is greater than zero for some values of t and equal to or less than zero for other values of t. Thus, a mixed investment contains unrecovered investment balances (when $F_t(r) < 0$) and also over-recovered investment balances (when $F_t(r) > 0$). Put differently, there are periods when the firm lends to the project and there are periods when the firm borrows from the project.

Two-Fold Classification

Using the definitions discussed above, investments may be classified into four categories:

- Simple, pure investments
- Simple, mixed investments
- Non-simple, pure investments
- Non-simple, mixed investments

As all simple investments are pure investments, there is no investment which is both simple and mixed. Hence, the classification scheme relevant for our purposes is as follows:



Relevance of IRR

To discuss the relevance of IRR for various investment classifications discussed above it is helpful to look at numerical illustrations. Exhibit 10C.1 presents cash flow data for four projects, *A*,*B*, *C*, and *D* . Project *A* is a simple project; project *B* is a non-simple pure project, project C is a non simple mixed project (as we shall see) which has a unique real root; project *D* is a non-simple mixed project (as we shall see) which has two real roots.

EXHIBIT 10C.1

Cash Flow Data for Four Projects

	Cash flow in Rupees			
Year	Project A	Project B	Project C	Project D
0	−5,000	−2,000	−50	−1,600
1	1,000	600	200	10,000
2	1,000	500	−200	−10,000
3	1,000	400	–	–
4	1,833	−378	–	–
5	5,000	1,800		

The IRR equation for project *A* is:

$$5{,}000 = \frac{1{,}000}{(1+r)} + \frac{1{,}000}{(1+r)^2} + \frac{1{,}000}{(1+r)^3} + \frac{1{,}833}{(1+r)^4} + \frac{5{,}000}{(1+r)^5}$$

On solving this equation, we obtain one real root, $r = 20$ per cent. Putting $r = 20$ per cent in Eq. (10C.1), we get the following investment balances:

$$\begin{aligned}
F_0\,(0.20) &= -5{,}000 \\
F_1\,(0.20) &= -5{,}000\,(1.20) + 1{,}000 = -5{,}000 \\
F_2\,(0.20) &= -5{,}000\,(1.20) + 1{,}000 = -5{,}000 \\
F_3\,(0.20) &= -5{,}000\,(1.20) + 1{,}000 = -5{,}000 \\
F_4\,(0.20) &= -5{,}000\,(1.20) + 1{,}833 = -4{,}167 \\
F_5\,(0.20) &= -4{,}167\,(1.20) + 5{,}000 = 0
\end{aligned}$$

We find that all the intermediate investment balances, $F_t\,(t = 0, \ldots, N-1)$ are negative whereas the terminal investment balance, F_5, is 0. This means that throughout its life the project is a net borrower. Hence the internal rate of return of 20 per cent is internal to the project.

The IRR equation for project *B* is:

$$2{,}000 = \frac{600}{(1+r)} + \frac{500}{(1+r)^2} + \frac{400}{(1+r)^3} + \frac{378}{(1+r)^4} + \frac{1{,}800}{(1+r)^5}$$

On solving this equation, we obtain only one real root: $r = 12$ per cent. Setting $r = 12$ per cent in Eq. (10C.1), we get the following investment balances:

$$
\begin{aligned}
F_0\,(0.12) &= -2{,}000 \\
F_1\,(0.12) &= -2{,}000\,(1.12) + 600 = -1{,}640 \\
F_2\,(0.12) &= -1{,}640\,(1.12) + 500 = -1{,}337 \\
F_3\,(0.12) &= -1{,}337\,(1.12) + 400 = -1{,}097 \\
F_4\,(0.12) &= -1{,}097\,(1.12) - 378 = -1{,}607 \\
F_5\,(0.12) &= -1{,}607\,(1.12) + 1{,}800 = 0
\end{aligned}
$$

We find that even for project *B*, which is a non-simple investment, the intermediate investment balances, $F_t\ (t = 0,\ldots,N-1)$ are negative whereas the terminal investment balance, F_5, is 0. This means that throughout its life the project is a net borrower. Hence the rate of return of 12 per cent is internal to the project.

The IRR equation for project *C* is: $50 = \dfrac{200}{(1+r)} - \dfrac{200}{(1+r)^2}$

On solving this equation we obtain two identical values for *r*: 100 per cent. Using this value we get the following investment balances as per Eq. (10C.1):

$$
\begin{aligned}
F_0\,(1.00) &= -50 \\
F_1\,(1.00) &= -50\,(2.00) + 200 = 100 \\
F_2\,(1.00) &= 100\,(2.00) - 200 = 0
\end{aligned}
$$

It may be noted that the unrecovered investment balance is negative in the beginning ($F_0 < 0$), positive at the end of year 1 ($F_1 > 0$), and zero at the end of year 2 ($F_2 = 0$). This implies that the firm has invested funds in the project during the period from $t = 0$ to $t = 1$ but has borrowed funds from the project during the period from $t = 1$ to $t = 2$. The project is a mixed investment since it is both a user of funds as well as a source of funds for the firm. This represents a problem concerning the interpretation of *r*. If the rate of interest imputed to funds borrowed from the project is same as the rate of return earned by the project when funds are committed to it, *r* can be viewed as a rate of return internal to the project. In general, however, the rate of interest imputed to funds borrowed from the project is different from the rate of return earned by the project when funds are committed to it. Hence, *r* cannot be considered as a rate of return internal to the project in the case of a mixed investment.

The IRR equation for project *D* is: $1{,}600 = \dfrac{10{,}000}{(1+r)} - \dfrac{10{,}000}{(1+r)^2}$

On solving this equation, we obtain two positive values for *r*:0.25 and 4.00. The investment balances with these values of *r* are shown below.

$$
\underline{r = 0.25}
$$

$$
\begin{aligned}
F_0\,(0.25) &= -1{,}600 \\
F_1\,(0.25) &= -1{,}600\,(1.25) + 10{,}000 = 8{,}000 \\
F_2\,(0.25) &= 8{,}000\,(1.25) - 10{,}000 = 0
\end{aligned}
$$

$$
\underline{r = 4.00}
$$

$$
\begin{aligned}
F_0\,(4.00) &= -1{,}600 \\
F_1\,(4.00) &= -1{,}600\,(5.00) + 10{,}000 = 2{,}000 \\
F_2\,(4.00) &= 2{,}000\,(5.00) - 10{,}000 = 0
\end{aligned}
$$

In both the cases we find that the investment balances indicate a mixed investment. Thus, in this problem, too, the solving value of r cannot be viewed as a rate of return internal to the project. Moreover, the multiple values of r seem to complicate the problem further. Hence IRR is not a serviceable criterion.

To sum up, we find that IRR is a meaningful criterion for pure investments but not for mixed investments. What criterion may be applied for mixed investments? The recommended criterion for mixed investments is the return on invested capital. This criterion takes into account properly the fact that mixed investments involve both lending and borrowing. Before we discuss the calculation of return on invested capital we need a procedure for distinguishing pure and mixed investments, which is discussed next.

Test for Pure and Mixed Investments

To test whether an investment is pure or mixed, we need to know $i_{\min}$. It is the minimum interest rate which makes investment balances $F_t(i) \le 0$ $(t = 0, \ldots, N - 1)$. It may be pointed out that since we are considering investments which have $F_0 < 0$, it is always possible to make $F_t\ (i) \le 0$ $(t = 0, \ldots, N - 1)$ by raising the interest rate. $i_{\min}$, of course, is the smallest value of i for which the non-positivity condition, $F_i < 0$ $(t = 0, \ldots, N - 1)$ is just satisfied. For example, the $i_{\min}$ for the oil pump project (Project D) is 525 per cent because with this interest rate the non-positivity condition is just satisfied. This is clear from the following investment balances:

$$F_0\ (5.25) = -1{,}600$$
$$F_1\ (5.25) = 0$$

It may be noted that since $F_t\ (i_{\min}) < 0$ $(t - 0, \ldots, N{-}1)$, $F_t < (i)$ $(t = 0, \ldots, N - 1)$ for all values of i greater than $i_{\min}$. This happens because F_t's which are already negative or zero at $i_{\min}$ will become more so when a value of i that is higher than $i_{\min}$ will become more so when a value of i that is higher than $i_{\min}$ is used.

Now let us look at the procedure for testing whether an investment is pure or mixed.

Step 1 Find the value of $i_{\min}$ for the investment.

Step 2 Find the value of i^* which satisfies the condition $F_N\ (i^*) = 0$

Step 3 Compare i^* with $i_{\min}$. If $i^* > i_{\min}$ then the investment is pure investment, if $i^* < i_{\min}$ the investment is a mixed investment.

Mixed Investment and Return on Invested Capital

In the case of mixed investment, the firm commits funds to the project part of the time and borrows funds from the project rest of the time. To analyse a mixed investment, we need to distinguish between r^*, the return on invested capital, and k, the cost of funds borrowed from the project. When the unrecovered investment balance in the project is negative (that is, when the firm has funds committed to the project), it should be compounded at r^*; when the unrecovered investment balance in the project is positive (that is, when the firm has overdrawn funds from the project), it is compounded at k. As the unrecovered investment balance depends on both r^* and k, it is expressed as $F_1\ r^*, k$). Since the project terminates in year N, $F_N\ (r^*, k) = 0$ is the condition for realising a return on invested capital of r^*. This defines the functional relationship between r and k.

The procedure outlining the steps involved in determining the return on invested capital r^* as a function of k is described below.

Step 1 Determine whether the investment is a pure investment or mixed investment. If the investment is a pure investment, the internal rate of return is also the return on invested capital. If the investment is a mixed investment, proceed with step 2.

Step 2 Calculate $F_t(r^*, k)$ according to the rule

$$
\begin{aligned}
F_0\,(r^*, k) &= CF_0 \\
F_1\,(r^*, k) &= F_0\,(1+r^*) + CF_1 \text{ if } F_0 < 0 \\
& F_0\,(1+k) + CF_2 \text{ if } F_0 > 0 \\
F_t\,(r^*, k) &= F_{t-1}\,(1+r^*) + CF_t \text{ if } F_{t-1} < 0 \\
&= F_{t-1}\,(1+k) + CF_t \text{ if } F_{t-1} > 0 \\
F_N\,(r^*, k) &= F_{N-1}\,(1+r^*) + CF_N \text{ if } F_{N-1} < 0 \\
& F_{N-1}\,(1+k) + CF_N \text{ if } F_{N-1} > 0
\end{aligned}
$$

Step 3 Obtain the value of r^* by solving the equation

$$F\,(r^*, k) = 0$$

In applying the above procedure, a problem arises: To determine whether the compounding is to be done at r^* or k at any stage, we need to know whether the unrecovered investment balance at that stage is negative or positive. This problem can be resolved because we know the upper and lower bounds for r^* as r^* cannot be negative and cannot exceed $i_{\min}$. This point is illustrated below where the procedure for calculating the return on invested capital is applied to the oil pump project.

Application of the Procedure to the Oil Pump Project

Step 1 This project has two values for r: 25 per cent and 400 per cent..Both these values are less than $i_{\min}$ which is 525 per cent. So the project is a mixed project.

Step 2 Obtain the value $F_t\,(r^*, k)$ recursively as follows:

$$
\begin{aligned}
F_0\,(r^*, k) &= CF_0 = -1{,}600 \\
F_1\,(r^*, k) &= -1{,}600\,(1+r^*) + 10{,}000 \\
&= 8{,}400 - 1{,}600\,r^* \quad (F_0 < 0)
\end{aligned}
$$

(Since r^* cannot exceed $i_{\min} = 5.25$,

$1{,}600\,r^*\ 8{,}400$,

Hence $F_1\,(r^*, k) > 0$

So it is compounded at k in the next step)

$$
\begin{aligned}
F_2\,(r^*, k) = {} & (8{,}400 - 1{,}600\,r^*)\,(1+k) \\
& - 10{,}000
\end{aligned}
$$

Step 3 Solve $F_2\,(r^*, k) = 0$

$$(8{,}400 - 1{,}600\,r^*)\,(1+k) - 10{,}000 = 0$$

This gives

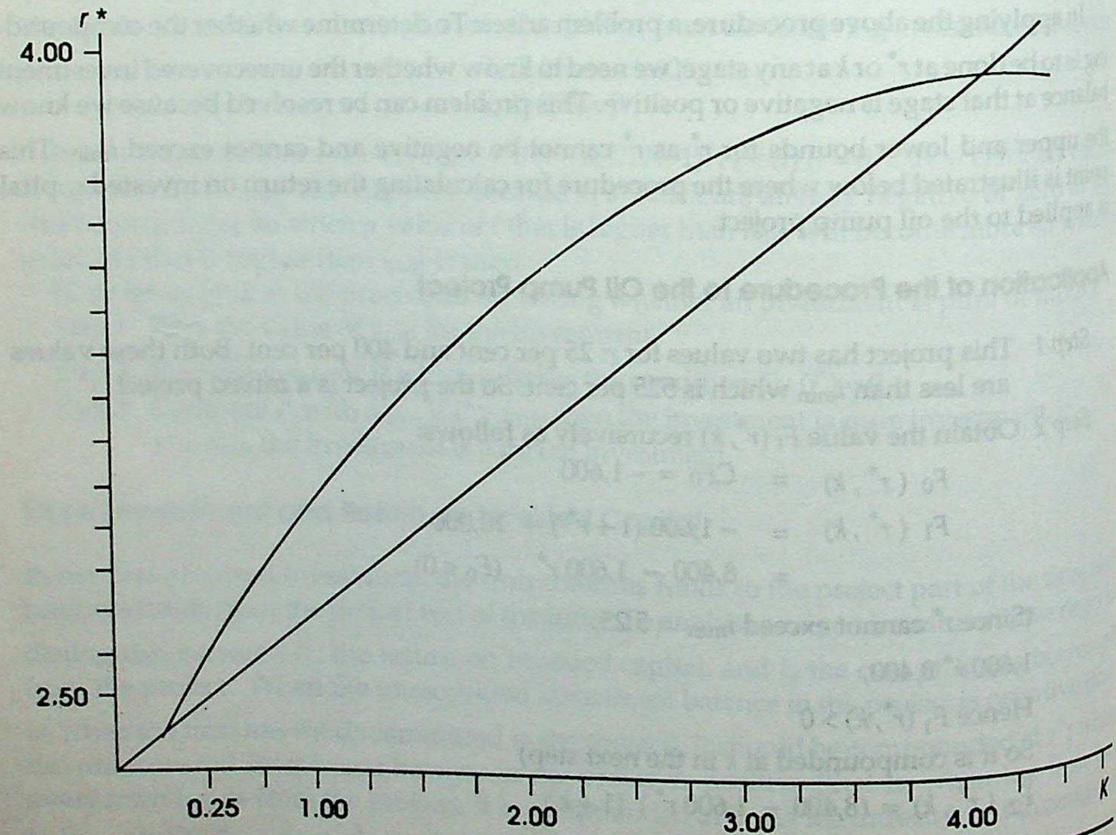
$$r^* = 5.25 - \frac{6.25}{(1+k)} \qquad (10C.4)$$

Equation (10C.4) expresses the relationship between return on invested capital, r^* and the imputed cost of funds, k. It shows clearly that for a mixed investment the return on invested capital is a function of imputed cost of excess funds provided by the project to the firm. A graphical solution of Eq. (10C.4) is given in Exhibit 10C.2.

On the basis of the relationship between r^* and k, several inferences may be drawn: (i) The return on invested capital, r^*, increase as k, the imputed cost of surplus funds, increases. (ii) There is an upper limit to r^*, which is simply $i_{\min}$. r^* approaches $i_{\min}$ asymptotically. (iii) If $k = r^*$ in Eq. (10C.4), then they are also equal to i^* (0.25, 4.00) which is the solving rate of return for F_N $(i^* = 0)$.

EXHIBIT 10C.2

Relationship Between r^* and k



11

Analysis of Risk

For the sake of expository convenience, we assumed so far that all capital investment proposals had the same level of risk and hence the same discount rate (the firm's cost of capital) could be applied across the board. Capital investment proposals, however, differ in their risk exposure. A diversification proposal is likely to be more risky than an expansion proposal which, in turn, tends to be more risky than a replacement proposal.

In view of such differences, variations in risk need to be considered properly in capital investment analysis. To emphasise this point, suppose that you have a choice between two alternatives, *A* and *B*, each involving the same investment but offering different outcomes as shown below:

	Possible outcome	*Probability*
A	8,000	0.5
	0	0.5
B	4,000	1.0

Which alternative would you choose? If you are a risk-averse decision maker, like most others, you would choose *B*. Why? While the expected outcome of both *A* and *B* is the same, *A*'s outcome is highly variable compared to *B*'s certain outcome. You choose *B* because risk (variability) matters.

In the extensive literature of capital budgeting, a variety of approaches have been developed to handle risk. This chapter discusses the approaches that are helpful in analysing the risk of a project when it is viewed in isolation. It is divided into eight sections:

- Types and measures of risk
- Analytical derivation or simple estimation
- Sensitivity analysis
- Scenario analysis
- Monte Carlo simulation
- Decision tree analysis
- Selection of a project
- Risk analysis in practice

TYPES AND MEASURES OF PROJECT RISK

Types of Project Risk

You can look at the risk of a project from different perspectives. At least three distinct types of project risks may be identified.

- *Stand alone risk* This represents the risk of a project when it is viewed in isolation.
- *Firm risk* Also called corporate risk, this reflects the contribution of a project to the risk of the firm.
- *Systematic risk* Also called market risk, this represent the risk of a project in the context of the market portfolio.

This chapter dwells on stand-alone risk; Chapter 13 discusses firm risk and market risk.

Measures of Risk

Risk refers to variability, of which there are several measures. The important ones are:

- Range
- Mean absolute deviation
- Standard deviation
- Coefficient of variation
- Semi-variance

These measures are defined below:

Range $$R_g = R_h - R_l \tag{11.1}$$

Mean absolute deviation $$\text{MAD} = \sum p_i \mid R_i - \overline{R} \mid \tag{11.2}$$

Standard deviation $$\sigma = \left[\sum p_i (R_i - \overline{R})^2 \right]^{1/2} \tag{11.3}$$

Coefficient of variation $$\text{CV} = \frac{\sigma}{\overline{R}} \tag{11.4}$$

Semi-variance $$\text{SV} = \sum p_i (R_i - R)'^2 \tag{11.5}$$

where R_h = highest possible outcome
R_l = lowest possible outcome
p_i = probability associated with the ith outcome
$\overline{R}$ = arithmetic average
$(R_i - R)' = (R_i - \overline{R})$ when $R_i < \overline{R}$ and 0 when $R_i > \overline{R}$

The computation of various measures of variability may be illustrated by an example. The probability distribution of the outcome of an investment is shown below:

Outcome Rs	*Probability*
900	0.2
600	0.5
200	0.3

$$\text{Range} = R_h - R_l = \text{Rs } 900 - \text{Rs } 200 = \text{Rs } 700$$

$$\text{MAD} = \sum_{i=1}^{n} p_i \mid R_i - \overline{R} \mid$$

$$= 0.2\,(360) + 0.5\,(60) + 0.3\,(340) = \text{Rs } 204$$

$$\sigma = \left[\sum p_i \, (R_i - \overline{R})^2 \right]^{1/2}$$

$$[\,0.2\,(900-540)^2 + 0.5\,(600-540)^2 + 0.3\,(200-540)^2\,]^{1/2}$$

$$\doteq \text{Rs } 250$$

$$\text{CV} = \frac{\sigma}{\overline{R}} = \frac{\text{Rs } 250}{\text{Rs } 540} = 0.46$$

$$\text{SV} = \sum p_i \, (R_i - R)'^2$$

$$= 0.2\,(0)^2 + 0.5\,(0)^2 + 0.3\,(340)^2$$

$$= \text{Rs } 34{,}680$$

Out of the above measures of risk, standard deviation is the most commonly used measure of risk in finance. The principal reasons for using standard deviation are as follows: (i) If a variable is normally distributed, its mean and standard deviation contain all the information about its probability distribution. (ii) If the utility of money is represented by a quadratic function (a function commonly suggested to represent diminishing marginal utility of wealth), then the expected utility is a function of mean and standard deviation. (iii) Standard deviation is analytically easily tractable.

Use of Subjective Probabilities For measuring the expected value and dispersion of a variable, its probability distribution is required. In some cases the probability distribution can be defined with a fairly high degree of objectivity on the basis of past evidence. A wildcatter, for example, may be able to define with a high degree of objectivity, the probabilities associated with certain states of nature if sufficient records for similar ventures are available. Since such a probability distribution is substantially based on objective facts, it may be referred to as an 'objective' probability distribution.

However, in most real life situations, such objective evidence may not be available for defining probability distributions. In such cases knowledgeable persons may pool their experience and judgement to define the probability distribution. Since there is likely to be a high element of subjectivity in these distributions, such distributions are generally referred to as '*subjective*' probability distributions.

ANALYTICAL DERIVATION OR SIMPLE ESTIMATION

Under certain circumstances, the expected net present value[1] and the standard deviation of net present value may be obtained through analytical derivation or simple estimation. Three cases of such analysis are discussed here: (i) no correlation among cash flows, (ii) perfect correlation among cash flows, and (iii) moderate correlation among cash flows.

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[1] For purposes of our present discussion, we shall regard net present value as the principal appraisal criterion. Hence our focus will be on the mean and standard deviation of net present value. The methods discussed here, however, can be applied to other criteria as well.

Uncorrelated Cash Flows

When the cash flows of different years are uncorrelated, the cash flow for year t is independent of the cash flow for year $t-r$. Put differently, there is no relationship between cash flows from one period to another. In this case the expected net present value and the standard deviation of net present value are defined as follows:

$$\overline{NPV} = \sum_{t=1}^{n} \frac{\overline{A}_t}{(1+i)^t} - I \tag{11.6}$$

$$\sigma\,(NPV) = \left[\sum_{t=1}^{n} \frac{\sigma_t^2}{(1+i)^{2t}}\right]^{1/2} \tag{11.7}$$

where $\overline{NPV}$ = expected net present value
$\overline{A}_t$ = expected cash flow for year t
i = risk-free interest rate
I = initial outlay
$\sigma\,(NPV)$ = standard deviation of net present value
σ_t = standard deviation of the cash flow for year t

In the above formulae, it may be noted, the discount rate is the risk-free interest rate because we try to separate the time value of money and the risk factor. The risk of the project, reflected in σ (*NPV*), is considered in conjunction with *NPV* computed with the risk-free discount rate. If the *NPV* is computed using a risk-adjusted discount rate and then if this is viewed along with σ (*NPV*), the risk factor would be double counted.

Example A project involving an outlay of Rs 10,000 has the following benefits associated with it:

Year 1		**Year 2**		**Year 3**	
Net cash flow	**Probability**	**Net cash flow**	**Probability**	**Net cash flow**	**Probability**
Rs 3,000	0.3	Rs 2,000	0.2	Rs 3,000	0.3
5,000	0.4	4,000	0.6	5,000	0.4
7,000	0.3	6,000	0.2	7,000	0.3

Calculate $\overline{NPV}$ and σ (*NPV*) assuming that i = 6 per cent.

$$\overline{NPV} = \sum_{t=1}^{3} \frac{\overline{A}_t}{(1+i)^t} - I$$

$$= \frac{5{,}000}{(1.06)} + \frac{4{,}000}{(1.06)^2} + \frac{5{,}000}{(1.06)^3} - 10{,}000 = \text{Rs } 2{,}475$$

$$\sigma(NPV) = \left[\sum \frac{\sigma_t^{\,2}}{(1+i)^{2t}}\right]^{1/2}$$

$$= \left[\frac{2{,}400{,}000}{(1.06)^2} + \frac{1{,}600{,}000}{(1.06)^4} + \frac{2{,}400{,}000}{(1.06)^6}\right]^{1/2}$$

$$= \text{Rs } 2{,}258$$

Perfectly Correlated Cash Flows

If cash flows are perfectly correlated, the behaviour of cash flows in all periods is alike. This means that if the actual cash flow in one year is α standard deviations to the left of its expected value, cash flows in other years will also be α standard deviations to the left of their respective expected values. Put in other words, cash flows of all years are linearly related to one another. The expected value and the standard deviation of net present value, when cash flows are perfectly correlated, are as follows:

$$\overline{NPV} = \sum_{t=1}^{n} \frac{\overline{A}_t}{(1+i)^t} - I \tag{11.8}$$

$$\sigma(NPV) = \sum_{t=1}^{n} \frac{\sigma_t}{(1+i)^t} \tag{11.9}$$

Example An investment project involves a current outlay of Rs 10,000. The mean and standard deviation of cash flows, which are perfectly correlated, are as follows:

Year	$\overline{A}_t$	σ_t
1	Rs 5,000	1,500
2	3,000	1,000
3	4,000	2,000
4	3,000	1,200

Calculate $\overline{NPV}$ and $\sigma(NPV)$, assuming a risk-free interest rate of 6 per cent.

$$\overline{NPV} = \sum_{t=1}^{4} \frac{\overline{A}_t}{(1+i)^t} - I$$

$$= \frac{5{,}000}{(1.06)} + \frac{3{,}000}{(1.06)^2} + \frac{4{,}000}{(1.06)^3} + \frac{3{,}000}{(1.06)^4} - 10{,}000$$

$$= \text{Rs } 3{,}121$$

$$\sigma(NPV) = \sum_{t=1}^{4} \frac{\sigma_t}{(1+i)^t}$$

$$= \frac{1{,}500}{(1.06)^1} + \frac{1{,}000}{(1.06)^2} + \frac{2{,}000}{(1.06)^3} + \frac{1{,}200}{(1.06)^4}$$

$$= \text{Rs } 4{,}935$$

Moderately Correlated Cash Flows

When the cash flows are moderately correlated and hence do not conform to the two patterns — independent and perfect correlation—described above, simple and convenient formulae cannot be used for assessing return and risk. Moderately correlated cash flows may be evaluated with the help of a series of conditional probability distributions. To illustrate this approach, let us consider a project which involves an outlay of Rs 100,000. The cash inflows expected to be generated by the project are shown in Exhibit 11.1. From the exhibit we find that there are eight possible cash flow streams. The first cash flow stream consists of Rs 30,000 in year 1, Rs 30,000 in year 2, and Rs 35,000 in year 3, the second cash flow stream consists of Rs 30,000 in year 1, Rs 30,000 in year 2, and Rs 40,000 in year 3, so on and so forth. The probabilities associated with these cash flow streams are given in the last column of the exhibit. It may be noted that the probability with which a cash flow stream occurs is simply the joint probability of the individual elements in that cash flow stream. The probability of the first cash flow stream, for example, is[2]:

$$P\text{ (Rs 30,000 in year 1)} \times P\text{ (Rs 30,000 in year 2/Given)}$$

$$\text{(Rs 30,000 in year 1)} \times P\text{ (Rs 35,000 in year 3/Given)}$$

$$\text{(Rs 30,000 in year 1 and Rs 30,000 in year 2)}$$

$$= (0.5)(0.8)(0.6) = 0.24$$

EXHIBIT 11.1

Conditional Probability Distribution Approach

Year 1		*Year 2*		*Year 3*			
Net cash flow	**Initial probability** *P*(1)	**Net cash flow**	**Conditional probability** *P*(2/1)	**Net cash flow**	**Conditional probability** *P*(3/2, 1)	**Cash flow stream**	**Joint probability** *P*(1, 2, 3)
30,000	0.5	30,000	0.8	35,000	0.6	1	0.24
				40,000	0.4	2	0.16
		40,000	0.2	45,000	0.5	3	0.05
				50,000	0.5	4	0.05
50,000	0.5	50,000	0.6	60,000	0.7	5	0.21
				70,000	0.3	6	0.09
		60,000	0.4	75,000	0.8	7	0.16
				90,000	0.2	8	0.04

The probability distribution of net present value of this project, given a risk-free interest rate of 6 per cent, is shown in Exhibit 11.2. From this probability distribution we find that

$$\overline{NPV} = \text{Rs } 21{,}186$$

$$\sigma(NPV) = \text{Rs } 33{,}647$$

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[2] The general rule for calculating the joint probability may be mentioned here:
$P(A_1, A_2, ..., A_n) = P(A_1)\, P(A_2/A_1) \times P(A_3/A_1, A_2) \times \ldots \times P(A_n/A_1, A_2, ..., A_{n-1})$

EXHIBIT 11.2

Probability Distribution of Net Present Value

Cash flow stream	Net present value	Probability
1	$\frac{30{,}000}{(1.06)} + \frac{30{,}000}{(1.06)^2} + \frac{35{,}000}{(1.06)^3} - 100{,}000 = -15{,}612$	0.24
2	$\frac{30{,}000}{(1.06)} + \frac{30{,}000}{(1.06)^2} + \frac{40{,}000}{(1.06)^3} - 100{,}000 = -11{,}414$	0.16
3	$\frac{30{,}000}{(1.06)} + \frac{40{,}000}{(1.06)^2} + \frac{45{,}000}{(1.06)^3} - 100{,}000 = 1{,}684$	0.05
4	$\frac{30{,}000}{(1.06)} + \frac{40{,}000}{(1.06)^2} + \frac{50{,}000}{(1.06)^3} - 100{,}000 = 5{,}882$	0.05
5	$\frac{50{,}000}{(1.06)} + \frac{50{,}000}{(1.06)^2} + \frac{60{,}000}{(1.06)^3} - 100{,}000 = 42{,}046$	0.21
6	$\frac{50{,}000}{(1.06)} + \frac{50{,}000}{(1.06)^2} + \frac{70{,}000}{(1.06)^3} - 100{,}000 = 50{,}442$	0.09
7	$\frac{50{,}000}{(1.06)} + \frac{60{,}000}{(1.06)^2} + \frac{75{,}000}{(1.06)^3} - 100{,}000 = 63{,}540$	0.16
8	$\frac{50{,}000}{(1.06)} + \frac{60{,}000}{(1.06)^2} + \frac{90{,}000}{(1.06)^3} - 100{,}000 = 76{,}134$	0.04

Standardising the Distribution

Knowledge of *NPV* and σ (*NPV*) is very useful for evaluating the risk characteristics of a project. If the *NPV* of a project is approximately normally distributed, we can calculate the probability of *NPV* being less than or more than a certain specified value. This probability is obtained by finding the area under the probability distribution curve to the left or right of the specified value. Suppose the probability distribution of *NPV* is as shown in Exhibit 11.3. If we want to calculate the probability of *NPV* being less than a specified value, say 0, we have to obtain the area under the probability distribution curve to the left of 0—this is indicated by the shaded region. If we are interested in finding the probability that *NPV* exceeds a certain value, say Rs 0.2 million, we calculate the area under the probability distribution curve to the right of Rs 0.2 million—this area is shown as the shaded region.

How can we calculate the area to the left or right of a specified point? To calculate the area to the left or right of a specified point, we use the following procedure.

Step 1 Standardise the difference between the specified point and *NPV*. To do this the difference between the specified point and *NPV* is divided by σ (*NPV*). The standardised difference may be referred to as Z. The purpose of standardisation is to transform the actual distribution of *NPV* into a standard normal distribution. The standard normal distribution has a mean of 0 and standard deviation of 1. Exhibit 11.4 shows a standard normal distribution.

EXHIBIT 11.3

Area Under a Normal Distribution Curve

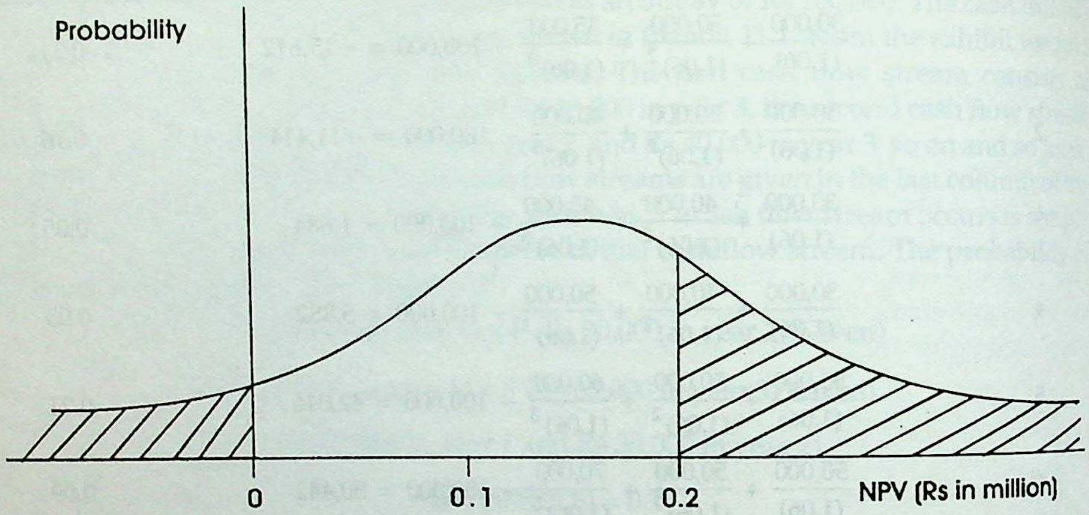
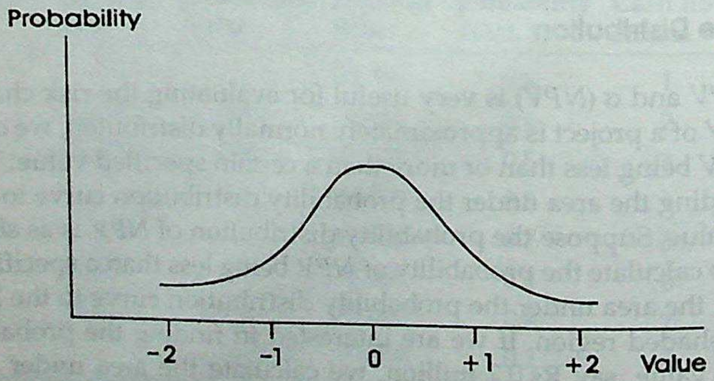


EXHIBIT 11.4

Standard Normal Distribution



Step 2 Refer to the standard normal distribution table and find the probability to the left (or right depending on our interest) of the *Z* value obtained in step 1.

To illustrate the above procedure suppose that a project's *NPV* and σ (*NPV*) are Rs 96,000 and Rs 60,000 respectively and we want to find the probability that *NPV* will be less than 0. This may be done as shown in Exhibit 11.5.

EXHIBIT 11.5

Cumulative Probability up to *Z* for Standard Normal Distribution

Z	Cumulative probability	Z	Cumulative probability
– 3.0	0.001	0.2	0.579
– 2.8	0.003	0.4	0.655
– 2.6	0.005	0.6	0.726
– 2.4	0.008	0.8	0.788
– 2.2	0.014	1.0	0.841
– 2.0	0.023	1.2	0.885
– 1.8	0.036	1.4	0.919
– 1.6	0.055	1.6	0.945
– 1.4	0.081	1.8	0.964
– 1.2	0.115	2.0	0.977
– 1.0	0.159	2.2	0.986
– 0.8	0.212	2.4	0.992
– 0.6	0.274	2.6	0.995
– 0.4	0.345	2.8	0.997
– 0.2	0.421	3.0	0.999
– 0.0	0.500		

Step 1 The standardised difference between the specified point ($NPV = 0$) and $\overline{NPV}$ = Rs 96,000 is

$$\frac{0 - 96{,}000}{60{,}000} = -1.6$$

Step 2 The cumulative probability up to $Z = -1.6$ as seen from the standard normal distribution given in Exhibit 11.5 is .055. This means that there is 5.5 per cent chance that *NPV* will be equal to or less than 0.

One more illustration may be given. Suppose that a project's $\overline{NPV}$ and $\sigma(NPV)$ are Rs 200,000 and Rs 150,000. What is the probability that *NPV* will be greater than Rs 380,000? This question may be answered as follows:

Step 1 The standardised difference between the specified point (NPV = Rs 380,000) and $\overline{NPV}$ is

$$\frac{380{,}000 - 200{,}000}{150{,}000} = 1.2$$

Step 2 The cumulative probability to the right of $Z = 1.2$ is equal to:

$$1 - \text{cumulative probability up to } Z = 1.2$$

Referring to Exhibit 11.5 we find that the cumulative probability up to $Z = 1.2$ is .885. Hence, the probability to the right of $Z = 1.2$ is:

$$1 - 0.885 = 0.115$$

This means that the probability that *NPV* will be greater than Rs 380,000 is 0.115.

SENSITIVITY ANALYSIS

Sensitivity analysis, sometimes called 'what if' analysis, answers questions like:

- What will happen to net present value (or some other criterion of merit) if sales are only 50,000 units rather than the expected 75,000 units?
- What will happen to net present value if the economic life of the project is only five years, rather than the expected eight years?

Procedure

Fairly simple, sensitivity analysis consists of the following steps:

1. Set up the relationship between the basic underlying factors (like the quantity sold, unit selling price, life of the project, etc.) and net present value (or some other criterion of merit).
2. Estimate the range of variation and the most likely value of each of the basic underlying factors.
3. Study the effect on net present value of variations in the basic variables. (Typically one factor is varied at a time.)

Illustration

Anischit Enterprises is analysing an investment proposal. The following net present value relationship has been set up:

$$NPV = \sum_{t=1}^{n} \frac{[Q(P-V)-F-D](1-T)+D}{(1+k)^t} + \frac{S}{(1+k)^n} - I \tag{11.10}$$

where NPV = net present value of the project
Q = number of units sold annually
P = selling price per unit
V = variable cost per unit
F = total fixed costs, excluding depreciation and interest
D = annual depreciation charge
T = income tax rate
k = cost of capital
n = project life in years
S = net salvage value
I = initial cost

The range and most likely value of each of the basic variables are given in Exhibit 11.6.

Given the range and most likely value of basic variables, we can study the impact of variation in each variable on net present value, holding other variables constant at their most likely levels. To illustrate the nature of this analysis we shall look at the relationship between (i) k and NPV, and (ii) P and NPV.

k and NPV The relationship between k and NPV given the most likely values of other variables is:

EXHIBIT 11.6

Range and Most Likely Value of Basic Variables

Variable	Range	Most likely value
Q	1,000 – 2,000	1,600
P	Rs 600 – Rs 1,000	Rs 750
V	Rs 300 – Rs 500	Rs 400
F	Rs 120,000 – Rs 120,000	Rs 120,000
D	Rs 160,000 – Rs 160,000	Rs 160,000
T	0.60 – 0.60	0.60
k	0.08 – 0.11	0.10
n	5 – 5	5
S	Rs 400,000 – Rs 400,000	Rs 400,000
I	Rs 1,200,000 – Rs 1,200,000	Rs 1,200,000

$$NPV = \sum_{t=1}^{5} \frac{[\,1{,}600\,(750-400)\;-\;120{,}000-160{,}000\,]\,(1-0.6)+160{,}000}{(1+k)^{t}}$$

$$+\;\frac{400{,}000}{(1+k)^{5}}\;-\;12{,}00{,}000$$

$$=\sum_{t=1}^{5} \frac{272{,}000}{(1+k)^{t}}+\frac{400{,}000}{(1+k)^{5}}\;-\;12{,}00{,}000$$

The net present value for various values of k is shown below. The same relationship is shown graphically in Exhibit 11.7.

k	8%	9%	10%	11%
NPV	Rs 158,080	118,080	79,552	42,700

P and NPV The relationship between P and NPV, given the most likely values of other factors, is:

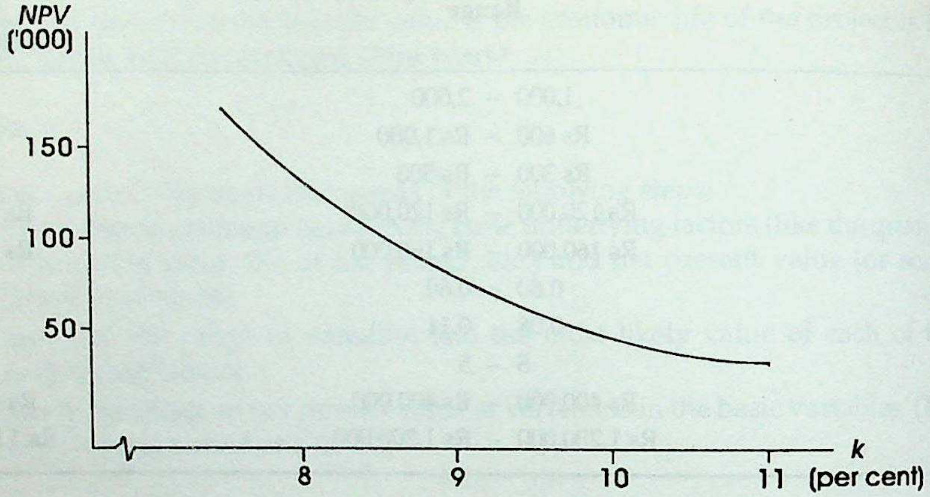
$$NPV = \sum_{t=1}^{5} \frac{[\,1{,}600\,(P-400)\;-\;120{,}000-160{,}000\,]\,(1-0.6)+160{,}000}{(1.10)^{5}}$$

$$+\;\frac{400{,}000}{(1.10)^{5}}\;-\;12{,}00{,}000$$

$$=\;\sum_{t=1}^{5} \frac{640P}{(1.10)^{t}}-\sum_{t=1}^{5}\frac{208{,}000}{(1.10)^{t}}+\frac{400{,}000}{(1.10)^{5}}\;-\;12{,}00{,}000$$

EXHIBIT 11.7

Relationship Between *k* and *NPV*

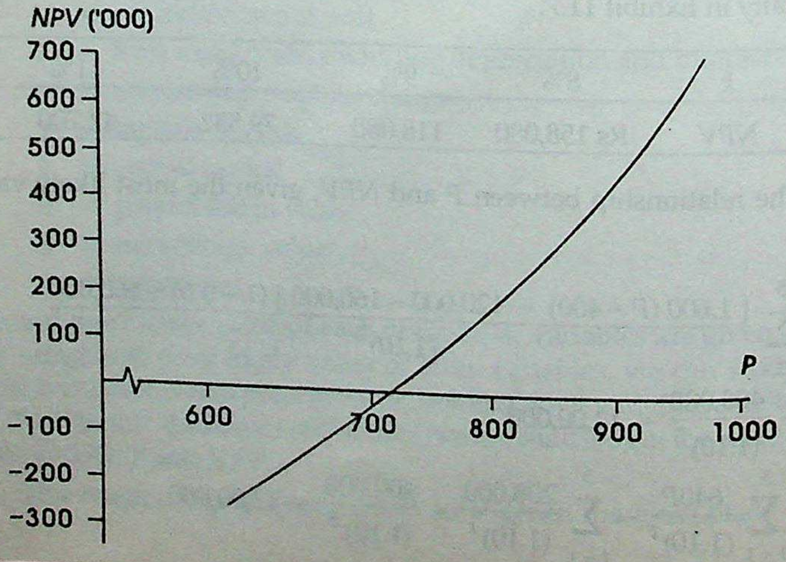


The net present value for various values of P is shown below. The same relationship is shown graphically in Exhibit 11.8.

P	600	700	750	800	900	1,000
NPV	– Rs 284,384	– 41,760	79,552	200,864	443,488	686,112

EXHIBIT 11.8

Relationship Between *P* and *NPV*



A useful way of presenting the results of sensitivity analysis is to show how the net present value behaves for different percentages of unfavourable changes (from their most likely values) in the basic variables. The behaviour of net present value when there is 5 per cent, 10 per cent, 15 per cent, and 20 per cent unfavourable change in *k*, other factors remaining unchanged at their most likely levels, is shown below:

Percentage unfavourable variation	Value of *k*	Net present value
5	10.5	60,418
10	11.0	42,700
15	11.5	24,681
20	12.0	7,575

The behaviour of net present value when there is 5 per cent, 10 per cent, 15 per cent, and 20 per cent unfavourable variation in *P* is shown below:

Percentage unfavourable variation	Value of *P*	Net present value
5	713	(10,308)
10	675	(102,500)
15	638	(192,267)
20	600	(284,384)

Exhibit 11.9 shows graphically the behaviour of net present value for various unfavourable percentage variations of *k* and *P*. Such a visual presentation is helpful in identifying variables which are crucial to the success of the project.

Evaluation

Sensitivity analysis, a popular method for assessing risk, has certain merits:

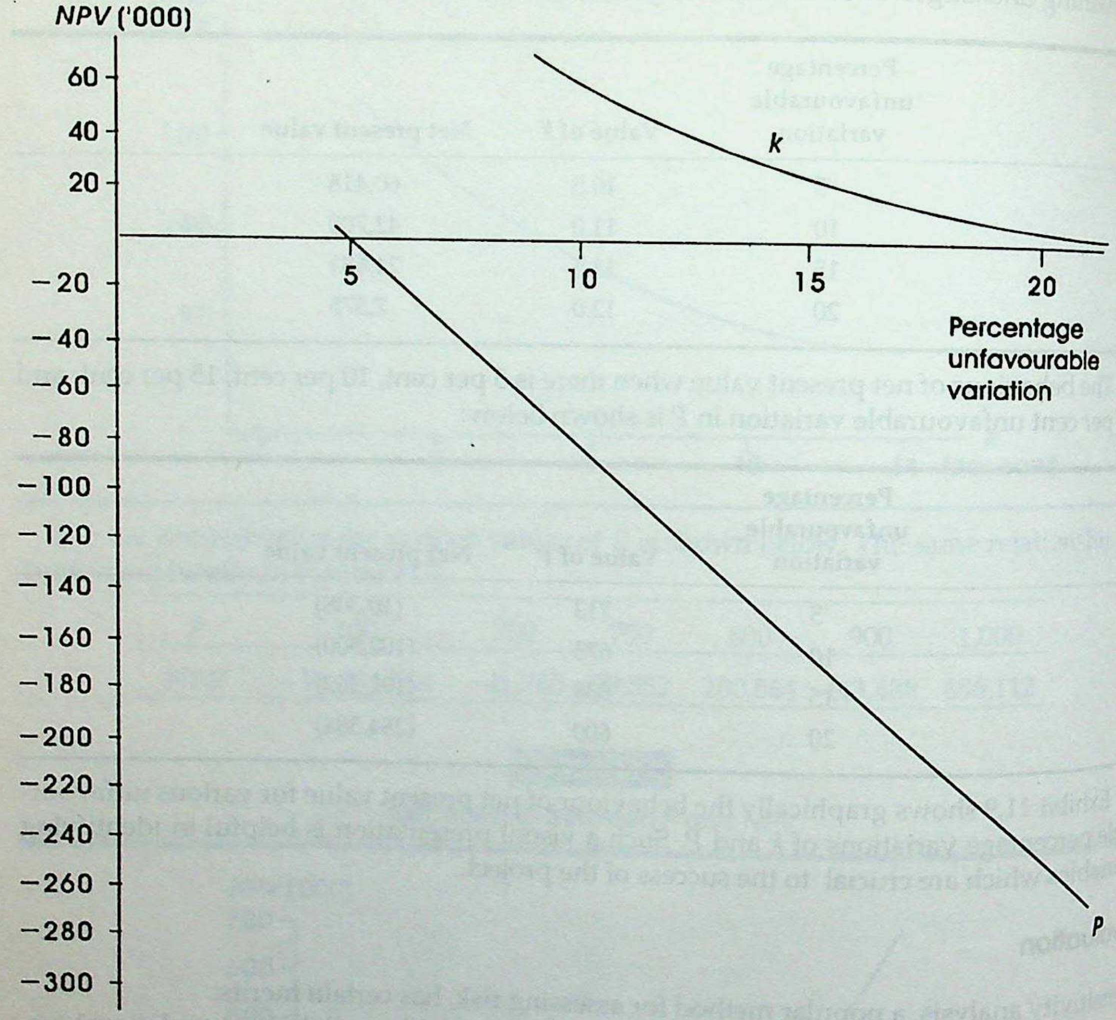
- It forces management to identify the underlying variables and their interrelationships.
- It shows how robust or vulnerable a project is to changes in the underlying variables.
- It indicates the need for further work. If the net present value or internal rate of return is highly sensitive to changes in some variable, it is desirable to gather further information about that variable.

Sensitivity analysis, however, suffers from severe limitations:

- It may fail to provide leads—if sensitivity analysis merely presents a complicated set of switching values it may not shed light on the risk characteristics of the project.
- The study of the impact of variation in one factor at a time, holding other factors constant, may not be very meaningful when the underlying factors are likely to be interrelated. What sense does it make to consider the effect of variation in price while holding quantity (which is likely to be closely related to price) unchanged?

EXHIBIT 11.9

Behaviour of *NPV* for Unfavourable Percentage Variations of *k* and *NPV*



SCENARIO ANALYSIS

In sensitivity analysis, typically one variable is varied at a time. If variables are inter-related as they are most likely to be, it is helpful to look at some plausible scenarios, each scenario representing a consistent combination of variables. For example, a project may be evaluated under three different scenarios:

1. The base case scenario where the demand and price are expected to be normal.
2. The scenario where the demand is high, but the price low.
3. The scenario where the demand is low, but the price high.

Exhibit 11.10 shows the net present value calculation for the three scenarios.

EXHIBIT 11.10

Net Present Value Calculation for Three Scenarios

(Rs in million)

	Scenario 1	Scenario 2	Scenario 3
Initial investment	200	200	200
Unit selling price (in rupees)	25	15	40
Demand	20	40	10
Revenues	500	600	400
Variable cost	240	480	120
Fixed cost	50	50	50
Depreciation	20	20	20
Pre-tax profit	190	50	210
Tax @ 50%	95	25	105
Profit after tax	95	25	105
Annual cash flow	115	45	125
Project life	10 years	10 years	10 years
Salvage value	0	0	0
Net present value (at a discount rate of 15 per cent)	377.2	25.9	427.4

In the above example, an attempt was made to develop scenarios in which the values of variables were internally consistent. (For example, high selling price and low demand typically go hand in hand.) Firms often do a different kind of scenario analysis in which the following scenarios are considered:

Optimistic scenario	High demand, high selling price, low variable cost, and so on.
Normal scenario	Average demand, average selling price, average variable cost, and so on.
Pessimistic scenario	Low demand, low selling price, high variable cost, and so on.

The objective of such scenario analysis may be to get a feel of what happens under the most favourable or the most adverse configuration of key variables, without bothering much about the internal consistency of such configurations.

MONTE CARLO SIMULATION

Sensitivity analysis indicates the sensitivity of the criterion of merit (*NPV*, *IRR*, or any other) to variations in basic factors and provides information of the following type: If the quantity produced and sold decreases by 1 per cent, other things being equal, the *NPV* falls by 6 per cent. Such information, though useful, may not be adequate for decision making. The decision maker would also like to know the likelihood of such occurrences. This information can be generated by *Monte Carlo Simulation* which may be used for developing the probability profile of a criterion of merit by randomly combining values of variables which have a bearing on the chosen criterion.

Procedure

The steps involved in simulation are given below:

1. Model the project: The model of the project shows how the net present value is related to the parameters and the exogenous variables. (Parameters are input variables specified by the decision maker and held constant over all simulation runs. Exogenous variables are input variables which are stochastic in nature and outside the control of the decision maker.)
2. Specify the values of parameters and the probability distributions of the exogenous variables.
3. Select a value, at random, from the probability distributions of each of the exogenous variables.
4. Determine the net present value corresponding to the randomly generated values of exogenous variables and pre-specified parameter values.
5. Repeat steps (3) and (4) a number of times to get a large number of simulated net present values.
6. Plot the frequency distribution of the net present value.

Illustration

To illustrate the nature of simulation a simple example is given here. Zenith Chemicals is evaluating an investment project. There is uncertainty associated with two aspects of this project: annual net cash flow and life of the project. The net present value model for the project is:

$$NPV = \sum_{t=1}^{n} \frac{CF_t}{(1+i)^t} - I \qquad (11.11)$$

In the net present value model embodied in Eq. (11.11), i, the risk-free interest rate, and I, the initial investment, are parameters (i = 10 per cent and I = Rs 13,000) whereas CF_t and n are stochastic exogenous variables with the following distributions.

Annual cash flow		Project life	
Value	*Probability*	*Value*	*Probability*
Rs		Years	
1,000	0.02	3	0.05
1,500	0.03	4	0.10
2,000	0.15	5	0.30
2,500	0.15	6	0.25
3,000	0.30	7	0.15
3,500	0.20	8	0.10
4,000	0.15	9	0.03
		10	0.02

The firm wants to perform 10 manual simulation runs for this project. To perform the simulation runs, we have to generate values, at random, for the two exogenous variables: annual cash flow and project life. For this purpose, we have to (i) set up the correspondence between the values of exogenous variables and random numbers, and (ii) choose some random number generating device. Exhibit 11.11 shows the correspondence between various values of exogenous variables and two digit random numbers. Exhibit 11.12 presents a table of random digits[3] that will be used for obtaining two digit random numbers.

EXHIBIT 11.11

Correspondence Between Values of Exogenous Variables and Two Digit Random Numbers

Annual cash flow				Project life			
Value	*Probability*	*Cumulative probability*	*Two digit random numbers*	*Value*	*Probability*	*Cumulative probability*	*Two digit random numbers*
Rs				Years			
1,000	0.02	0.02	00 to 01	3	0.05	0.05	00 to 04
1,500	0.03	0.05	02 to 04	4	0.10	0.15	05 to 14
2,000	0.15	0.20	05 to 19	5	0.30	0.45	15 to 44
2,500	0.15	0.35	20 to 34	6	0.25	0.70	45 to 69
3,000	0.30	0.65	35 to 64	7	0.15	0.85	70 to 84
3,500	0.20	0.85	65 to 84	8	0.10	0.95	85 to 94
4,000	0.15	1.00	86 to 99	9	0.03	0.98	95 to 97
				10	0.02	1.00	98 to 99

Now we are ready for simulation. In order to obtain random numbers from the table in Exhibit 11.12 we may begin anywhere at random in the table and read any pair of adjacent columns (since we are interested in a two-digit random number) and read column-wise or row-wise.

For our example, let us use the first two columns of the table in Exhibit 11.12. Starting from the top, we will read down the column. For the first simulation run we need two two-digit random numbers, one for the annual cash flow and the other for the project life. These numbers are 53 and 97 and the corresponding values for cash flow and project life are Rs 3,000 and 6 years respectively. We go further in this manner. Exhibit 11.13 shows the random numbers so obtained and the results of simulation.

Obtaining Probability Distributions of Basic Variables

Defining the probability distributions of basic variables is an important step in simulation. In defining these distributions it must be borne in mind that often it is impossible to find the true distributions. The distributions that are defined in practice are based on the judgement of experts. Great care should be exercised in translating the judgement of experts into probability distributions.

Two approaches may be used for obtaining probability distributions. These may be called the *'portrait'* approach and the *'building block'* approach.

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[3] Extracted from Rand Corporation, *A Million Random Digits with 1,00,000 Normal Deviates*, Glencoe, Illinois: The Free Press, 1955.

EXHIBIT 11.12

Random Numbers

53479	81115	98036	12217	59526
97344	70328	58116	91964	26240
66023	38277	74523	71118	84892
99776	75723	03172	43112	83086
30176	48979	92153	38416	42436
81874	83339	14988	99937	13213
19839	90630	71863	95053	55532
09337	33435	53869	52769	18801
31151	58295	40823	41330	21093
67619	52515	03037	81699	17106

EXHIBIT 11.13

Simulation Results

	Annual cash flow		Project life		
Run	*Random number*	*Corresponding value of annual cash flow*	*Random number*	*Corresponding value of project life*	*Net present value*
1	53	3,000	97	9	4277
2	66	3,500	99	10	8506
3	30	2,500	81	7	(829)
4	19	2,000	09	4	(7660)
5	31	2,500	67	6	(2112)
6	81	3,500	70	7	4039
7	38	3,000	75	7	1605
8	48	3,000	83	7	1605
9	90	4,000	33	5	2163
10	58	3,000	52	6	66

The portrait approach is similar to the portrait method used for identifying suspects. According to this approach a standard probability distribution (normal, beta, chi-square, poisson, uniform, exponential, or any other) is drawn up, usually by a statistician, on the basis of the judgement expressed by the expert (informant). This is shown to the expert for his comments. The expert may suggest changes if the distribution does not conform with his judgement. For example, he may suggest that the probabilities at the tails should be greater or the probability of the modal value should be higher. The statistician modifies the earlier distribution to incorporate the changes suggested by the expert and presents it to the expert again. This process may be continued till the expert is satisfied that the probability distribution represents his judgement well.

This method suffers from a major limitation. The expert may accept a smooth distribution because he may be beguiled by the appearance of smooth curves and charmed by complicated formulae.

In the second approach, the probability distribution is defined by the expert. He attempts to quantify his judgement by a procedure which is as follows: (i) he chooses the range encompassing possible values; (ii) he divides the range into intervals which he thinks have different probabilities associated with them; (iii) he assigns probabilities to these intervals such that $\sum pi = 1$; (iv) he may divide intervals into sub-intervals if he feels that the probabilities within an interval are different; and (v) he continues this process till he arrives at a distribution which represents his judgement well.

This process often leads to a step rectangular distribution and has the following advantages: (i) the expert has complete freedom in expressing his judgement; and (ii) it squares well with the principle of using all available information, no more no less.

Problem of Correlation

We considered an example in which it was assumed that the probability distributions of various factors affecting the *NPV* were independent. In practice, correlations may exist among the distribution of several factors. For example, the number of units sold may be correlated with the price per unit.

When such a dependency exists the factors which are correlated should be considered together. For this purpose, the joint probability distribution of correlated factors has to be developed. This adds immensely to the problem of estimation.

In this context we must consider the choice relating to the level of disaggregation. The nature of this choice may be illustrated with an example. In an investment project the cost of production may be considered at different levels of details as shown in Exhibit 11.14.

Now the problem is: To which level of detail should we go? Should we define the probability distribution of cost of production without explicitly considering the probability distribution of various elements like cost of raw material, cost of fuels and utilities, cost of manpower? Or, should we consider explicitly the distributions of these elements? Should we go further and consider explicitly the distributions of sub-elements like cost of imported raw materials, cost of indigenous raw materials, so on and so forth?

Ideally, the greater the degree of disaggregation, the better it is because it contributes to clarity of judgement. However, disaggregated analysis calls for considering correlations explicitly, which is often a difficult task. By limiting the degree of disaggregation we consider correlations implicitly. If we choose to define the probability distribution of cost of production, without doing disaggregated analysis, we do not have to consider explicitly the correlations between, say, cost of raw material and cost of fuel. The distribution of cost of production would implicitly consider this.

The choice of the level of aggregation or disaggregation would be finally based on the trade-off between the advantages of clarity of judgement and the complexities of disaggregated analysis. Since the influence of correlations is more significant than that of the shape of any particular distribution, it may be preferable to limit disaggregation.

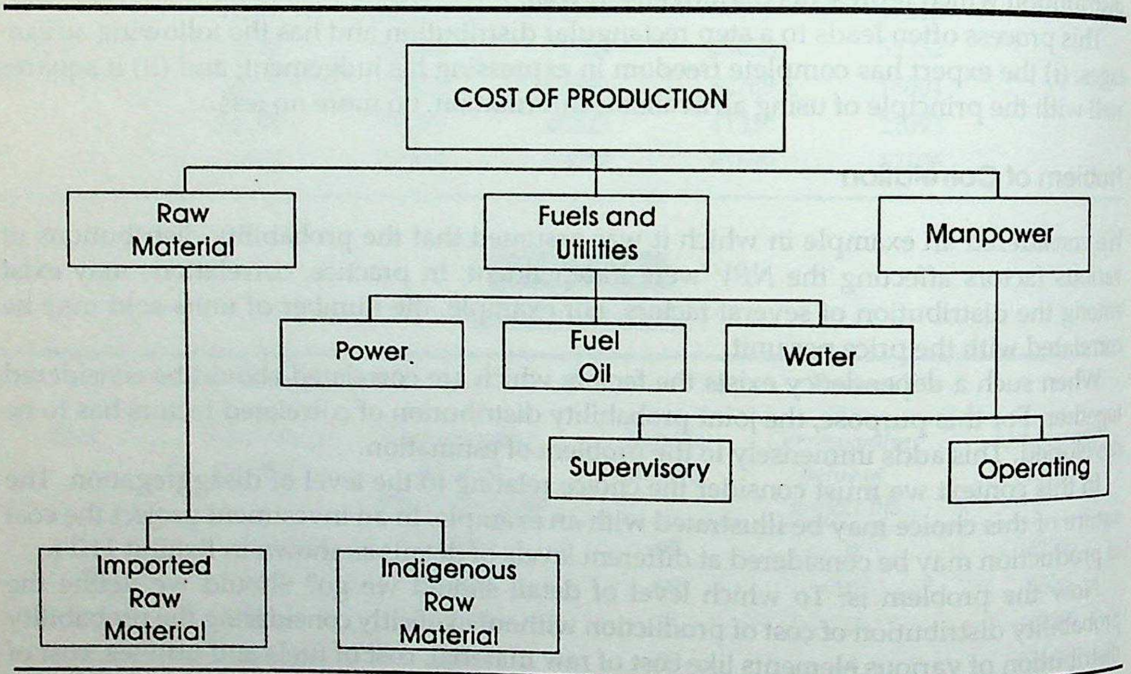
Issues in Applying Monte Carlo Simulation

Some of the important issues in the application of Monte Carlo simulation are:

- What should the output be?
- Is project variability enough?
- How should the extreme values be used?
- How should the results of simulation be used?

EXHIBIT 11.14

Levels of Detail



What Should the Output Be? Typically the output of simulation is the probability distribution of internal rate of return or net present value. The problem with the probability distribution of internal rate of return is that it only shows what the risk will be in the long run. It does not reflect the risk borne by investors in the capital market, which is captured by the distributions of successive one-period rates of return investors will earn, when investment is made in the project.

Is the probability distribution of net present value a better alternative? Here there is a problem about the discount rate to be used in the net present value calculation. If the cost of capital (which reflects the risk factor) is used as the discount rate, any further risk adjustment would mean double counting. If the risk-free rate of interest is used as the discount rate, then the underlying assumption is that the uncertainty about the project's cash flows would be resolved almost immediately. Since uncertainty is not resolved in this manner, the meaning of the simulated probability distribution is somewhat unclear.

In view of the problems associated with the distributions of internal rate of return and net present value, it perhaps makes sense to look at the distributions of cash flows (or earnings). If a project has an expected economic life of eight years, the project evaluator may examine eight separate cash flow distributions. These distributions may be scaled by their respective expected values for comparisons to be made between the projects.

Is Project Variability Enough? According to the *Capital Asset Pricing Model* (this model is discussed in Chapter 13), what matters is the systematic (non-diversifiable) risk of an investment and not its unsystematic (diversifiable) risk. Simulation can provide information on the total risk (which consists of systematic risk plus unsystematic risk), but it cannot separately show the systematic risk. Hence, a user of simulation must regard total risk as a proxy for systematic risk. Even though this is a strong assumption, it may not be unreasonable because empirical studies show a fairly reliable association between systematic risk and various measures of earnings volatility. Further, systematic risk tends to be proportional to total risk for firms operating in a single homogeneous industry.

How Should the Extreme Values be Interpreted? The proponents of simulation argue that, *inter alia*, it helps in answering questions like "What is the probability that *NPV* would be less than zero?" or "What is the probability that *IRR* would be less than *x* per cent?" These questions can be answered satisfactorily when the "tails" of the simulated distribution are reliable. However, the tails tend to be the least reliable part of the simulated distribution.

There is yet another, and perhaps more fundamental, problem in interpreting the tails of the simulated distribution. When a simulation model is constructed, it is assumed that the management will follow a strategy based on general business conditions it expects to encounter. Hence, the model cranks outnumbers on the basis of "business-as-usual" strategy even when it runs into surprises. In real life situations, however, managements modify their strategies to cope with surprises. When adverse developments occur, new actions are likely to be initiated. In extreme cases, the project may be abandoned to save future losses. Thus, the tails of the simulated distribution, which are important elements in risk assessment, are likely to reflect unrealistic management strategies.

How Should the Results of Simulation be Used? Hertz advocated simulation on the grounds that a probability distribution of the criterion of merit (*NPV* or *IRR*) leads to better decisions. This implies that a decision maker is able to reach a decision on the basis of the probability distribution. Not many executives, however, may be capable of reviewing the probability distribution of a project's *NPV* or *IRR* and deciding confidently whether the project is worthwhile or not. (Of course, there will be some projects which will be sure winners and some projects which will be sure losers—in these cases, however, simulation itself may be redundant.) A better approach to use the results of simulation may call for a two-stage decision making process:

Stage 1 Review the probability distributions of the project (i.e., probability distributions of cash flows, *IRR*, etc.) along with other factors and make an assessment.

Stage 2 Define the appropriate discount rate to be employed on the basis of the business risk assessment in stage 1.

Evaluation

An increasingly popular tool of risk analysis, simulation offers certain advantages:

- Its principal strength lies in its versatility. It can handle problems characterised by (a) numerous exogenous variables following any kind of distribution, and (b) complex interrelationships among parameters, exogenous variables, and endogenous variables. Such problems often defy the capabilities of analytical methods.

- It compels the decision maker to explicitly consider the inter-dependencies and uncertainties characterising the project.

Simulation, however, is a controversial tool which suffers from several shortcomings.

- It is difficult to model the project and specify the probability distributions of exogenous variables.
- Simulation is inherently imprecise. It provides a rough approximation of the probability distribution of net present value (or any other criterion of merit). Due to its imprecision, simulated probability distribution may be misleading when a tail of the distribution is critical.
- A realistic simulation model, likely to be complex, would most probably be constructed by a management scientist, not the decision maker. The decision maker, lacking understanding of the model, may not use it.
- To determine the net present value in a simulation run the risk-free discount rate is used. This is done to avoid prejudging risk which is supposed to be reflected in the dispersion of the distribution of net present value. Thus the measure net present value takes a meaning, very different from its usual one, that is difficult to interpret.

DECISION TREE ANALYSIS

The scientists at Vigyanik have come up with an electric moped. The firm is ready for pilot production which is estimated to cost Rs 0.8 million and take one year. If the results of pilot production are encouraging the next step would be to test market the product. This will cost Rs 0.3 million and take two months. Based on the outcome of the test marketing, a manufacturing decision may be taken. The firm may, however, skip the test marketing phase and take a decision whether it should manufacture the product or not. If the firm decides to manufacture the product commercially it is confronted with two options: a small plant or a large plant. This decision hinges mainly on the size of the market. While the level of demand in the short run may be gauged by the results of the test market, the demand in the long run would depend on how satisfied the initial users are.

If the firm builds a large plant initially it can cater to the needs of the market when demand growth is favourable. However, if the demand turns out to be weak, the plant would operate at a low level of capacity utilisation. If the firm builds a small plant, to begin with, it need not worry about a weak market and the consequent low level capacity utilisation. However, if the market turns out to be strong it will have to build another plant soon (and thereby incur a higher total outlay) in order to save itself from competitive encroachment.

To analyse situations of this kind where sequential decision making in the face of risk is involved, decision tree analysis is a useful tool. This section discusses the technique of decision tree analysis.

Steps in Decision Tree Analysis

The key steps in decision tree analysis are:

1. Identifying the problem and alternatives
2. Delineating the decision tree

3. Specifying probabilities and monetary outcomes
4. Evaluating various decision alternatives

Identifying the Problem and Alternatives To understand the problem and develop alternatives, information from different sources—marketing research, engineering studies, economic forecasting, financial analysis, etc.—has to be tapped. Imaginative effort must be made to identify the nature of alternatives that may arise as the decision situation unfolds itself and assess the kinds of uncertainties that lie ahead with respect to market size, market share, prices, cost structure, availability of raw material and power, technological changes, competitive action, and governmental regulation.

Recognising that risk and uncertainty are inherent characteristics of investment projects, persons involved in analysing the situation must be encouraged to express freely their doubts, uncertainties, and reservations and motivated to suggest contingency plans and identify promising opportunities in the emerging environment.

Delineating the Decision Tree The decision tree, exhibiting the anatomy of the decision situation, shows:

- The decision points (also called decision forks) and the alternative options available for experimentation and action at these decision points.
- The chance points (also called chance forks) where outcomes are dependent on a chance process and the likely outcomes at these points.

The decision tree reflects in a diagrammatic form the nature of the decision situation in terms of alternative courses of action and chance outcomes which have been identified in the first step of the analysis.

A decision tree can easily become very complex and cumbersome if an attempt is made to consider the myriad possible future events and decisions. Such a decision tree, however, is not likely to be a very useful tool of analysis. Over-elaborate, it may obfuscate the critical issues. Hence an effort should be made to keep the decision tree somewhat simple so that the decision makers can focus their attention on major future alternatives without being drowned in a mass of trivia. One must remember the advice of Brealey and Myers: "Decision trees are like grapevines; they are productive only if vigorously pruned."[4]

Specifying Probabilities and Monetary Values for Outcomes Once the decision tree is delineated, the following data have to be gathered:

- probabilities associated with each of the possible outcomes at various chance forks, and
- monetary value of each combination of decision alternative and chance outcome.

The probabilities of various outcomes may sometimes be defined objectively. For example, the probability of a good monsoon may be based on objective, historical data. More often, however, the possible outcomes encountered in real life are such that objective probabilities for them cannot be obtained. How can you, for example, define objectively the probability that a new product like an electric moped will be successful in the market? In such cases, probabilities have to be necessarily defined subjectively. This does not, however, mean that they are drawn from a hat. To be useful they have to be based on the experience, judgement, intuition, and understanding of informed and knowledgeable executives. Assessing the cash flows associated with various possible outcomes, too, is a difficult task. Again, the judgement of experts plays an important role.

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[4] R. Brealey and S. Myers, *Principles of Corporate Finance*, New York; McGraw-Hill Book Company, 1981, p.212.

Evaluating the Alternatives Once the decision tree is delineated and data about probabilities and monetary values gathered, decision alternatives may be evaluated as follows:

1. Start at the right-hand end of the tree and calculate the expected monetary value at various chance points that come first as we proceed leftward.
2. Given the expected monetary values of chance points in step 1, evaluate the alternatives at the final stage decision points in terms of their expected monetary values.
3. At each of the final stage decision points, select the alternative which has the highest expected monetary value and truncate the other alternatives. Each decision point is assigned a value equal to the expected monetary value of the alternative selected at that decision point.
4. Proceed backward (leftward) in the same manner, calculating the expected monetary value at chance points, selecting the decision alternative which has the highest expected monetary value at various decision points, truncating inferior decision alternatives, and assigning values to decision points, till the first decision point is reached.

Illustration

The technique of decision tree analysis may be explained with the help of an illustration. A wildcatter, evaluating a particular basin, is considering three alternatives: (i) He may drill. (ii) He may conduct a seismic experiment costing Rs 20,000 to find the nature of the underlying soil structure and decide on that basis. (iii) He may not do anything.

If he drills, he is likely to find one of the following oil-bearing states: dry, wet, or soaking. A dry well hardly yields anything; a wet well provides a moderate quantity of oil; a soaking well generates a substantial quantity of oil.

If he conducts a seismic experiment, he can learn about the underlying soil structure before deciding whether to drill or not. The underlying soil structure in this case may be one of the following types: no structure, open structure, or open structure. If no structure is discovered, the prospects of finding oil are bleak, if open structure is found the prospects of finding oil are fair, and if closed structure is discovered the prospects of finding oil are bright.

The decision tree corresponding to this situation is shown in Exhibit 11.15. It may be noted that, as a convention, a decision fork is represented by a square and a chance fork by a circle.

The decision tree delineated, the next phase of analysis calls for gathering information about probabilities and monetary values associated with various outcomes in the decision tree. The wildcatter reviews his experiences, analyses statistics relating to oil discoveries, and consults geological experts. He comes up with the following information:

Probabilities for Various Oil Bearing States If he drills without conducting seismic experiments the probabilities for various oil bearing states are:

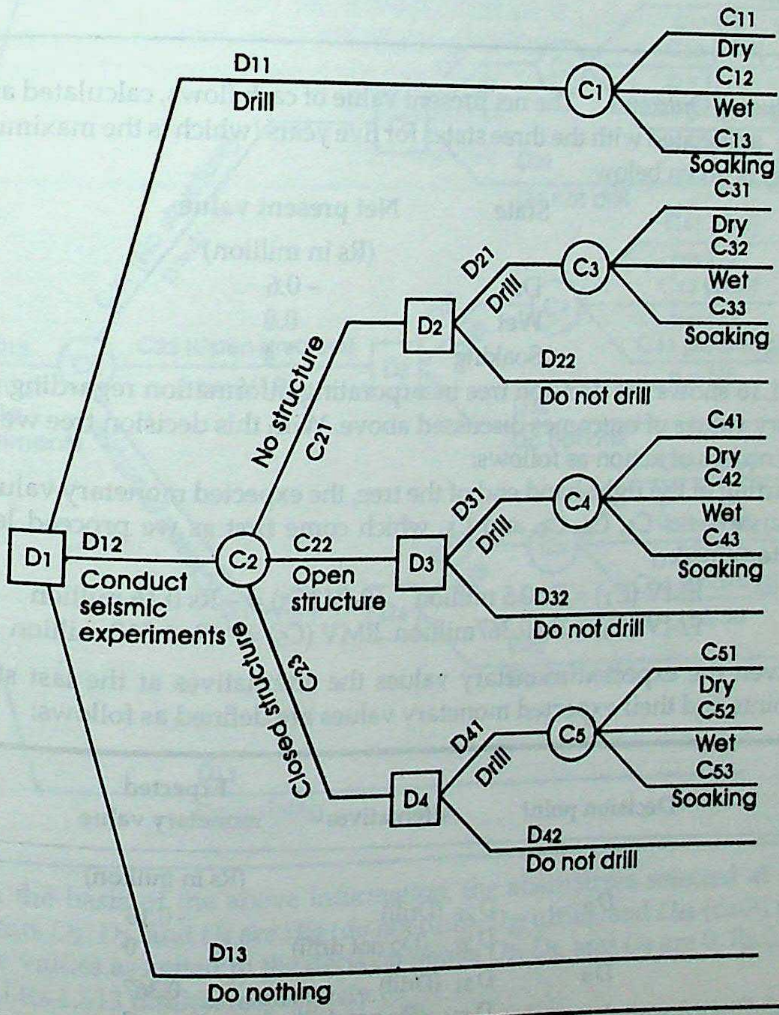
Oil bearing state	Probability
Dry	0.50
Wet	0.25
Soaking	0.25

Probabilities for Various Soil Structures If he conducts a seismic experiment he is likely to find the following underlying geological structures with probabilities mentioned against them:

Geological structure	Probability
No structure (NS)	0.40
Open structure (OS)	0.30
Closed structure (CS)	0.30

EXHIBIT 11.15

Decision Tree


D1
D11
Drill
C1
C11
Dry
C12
Wet
C13
Soaking
D12
Conduct seismic experiments
C2
C21
No structure
D2
D21
Drill
C3
C31
Dry
C32
Wet
C33
Soaking
D22
Do not drill
C22
Open structure
D3
D31
Drill
C4
C41
Dry
C42
Wet
C43
Soaking
D32
Do not drill
C23
Closed structure
D4
D41
Drill
C5
C51
Dry
C52
Wet
C53
Soaking
D42
Do not drill
D13
Do nothing

Relationship Between the Underlying Geological Structures and Oil Bearing States The relationship between the underlying geological structures and oil-bearing states expressed in terms of joint probabilities is as follows:

	Underlying geological structures			
Oil-bearing state	*No structure*	*Open structure*	*Closed structure*	*Marginal probability of state*
Dry	0.32	0.15	0.03	0.50
Wet	0.04	0.10	0.11	0.25
Soaking	0.04	0.05	0.16	0.25
Marginal probability of geological structure	0.40	0.30	0.30	1.00

Monetary Values of Outcomes The net present value of cash flows, calculated at 12 per cent discount rate, associated with the three states for five years (which is the maximum duration of oil drilling) is given below:

State	Net present value (Rs in million)
Dry	– 0.6
Wet	0.8
Soaking	2.4

Exhibit 11.16 shows the decision tree incorporating information regarding probabilities and monetary values of outcomes discussed above. With this decision tree we evaluate the alternative courses of action as follows:

1. Starting at the right-hand end of the tree, the expected monetary values (EMVs) at chance forks C_1, C_3, C_4, and C_5, which come first as we proceed leftwards, are determined:

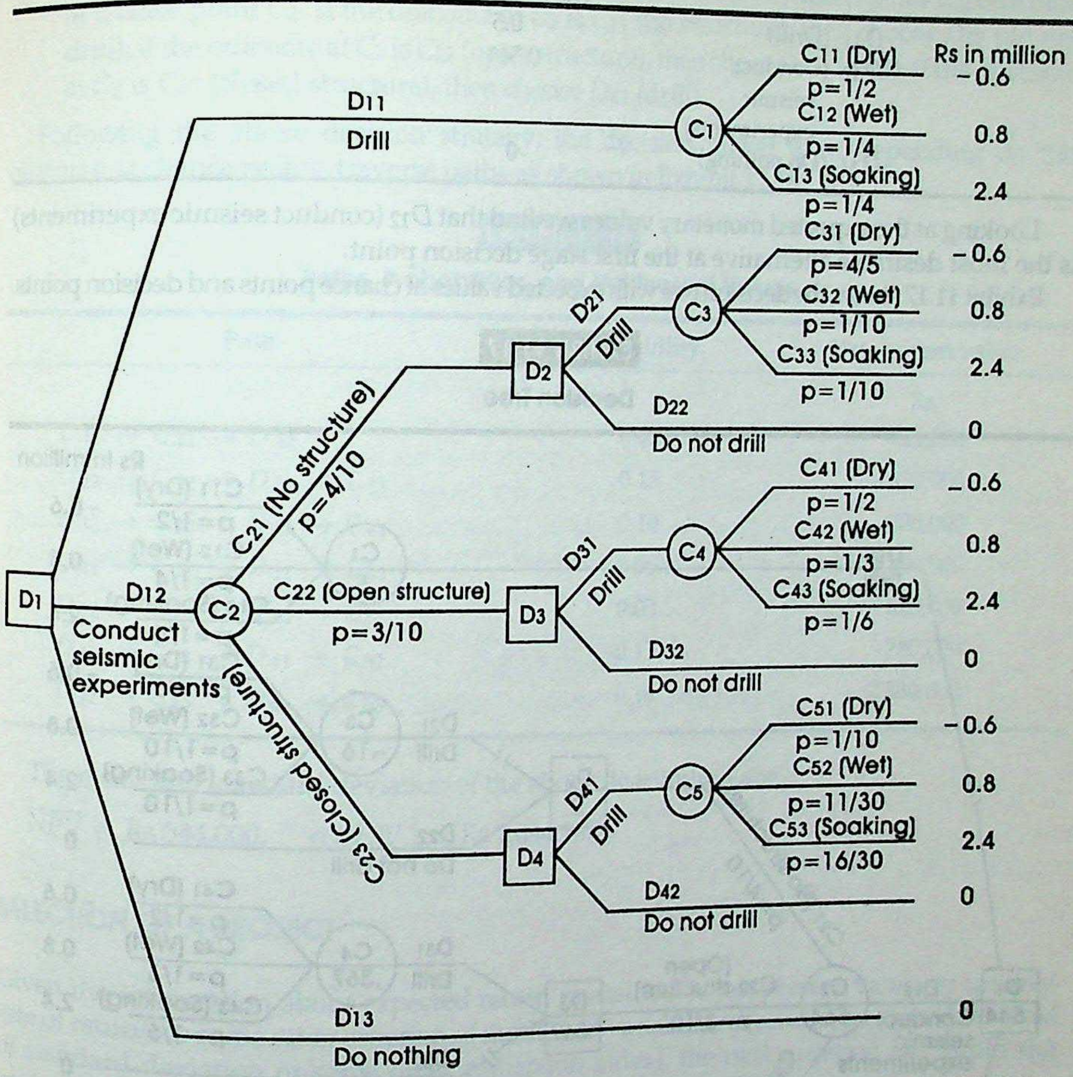
   EMV (C_1) = Rs 0.5 million EMV (C_3) = – Rs 0.16 million
   EMV (C_4) = Rs 0.367million EMV (C_5) = Rs 1.513 million

2. Given the expected monetary values the alternatives at the last stage decision points and their expected monetary values are defined as follows:

Decision point	Alternatives	Expected monetary value (Rs in million)
D_2	D_{21} (Drill)	– 0.16
	D_{22} (Do not drill)	0
D_3	D_{31} (Drill)	0.367
	D_{32} (Do not drill)	0
D_4	D_{41} (Drill)	1.513
	D_{42} (Do not drill)	0

EXHIBIT 11.16

Decision Tree


Rs in million
D11
Drill
C1
C11 (Dry)
p=1/2
−0.6
C12 (Wet)
p=1/4
0.8
C13 (Soaking)
p=1/4
2.4
C21 (No structure)
p=4/10
D2
D21
Drill
C3
C31 (Dry)
p=4/5
−0.6
C32 (Wet)
p=1/10
0.8
C33 (Soaking)
p=1/10
2.4
D22
Do not drill
0
D1
D12
Conduct seismic experiments
C2
C22 (Open structure)
p=3/10
D3
D31
Drill
C4
C41 (Dry)
p=1/2
−0.6
C42 (Wet)
p=1/3
0.8
C43 (Soaking)
p=1/6
2.4
D32
Do not drill
0
C23 (Closed structure)
D4
D41
Drill
C5
C51 (Dry)
p=1/10
−0.6
C52 (Wet)
p=11/30
0.8
C53 (Soaking)
p=16/30
2.4
D42
Do not drill
0
D13
Do nothing
0

3. On the basis of the above information, the alternatives selected at the decision points D_2, D_3, and D_4 are D_{22} (do not drill), D_{31} (drill), and D_{41} (drill) respectively. The values assigned to the decision points D_2, D_3, and D_4 are 0, Rs 0.367 million, and Rs 1.513 million respectively.
4. Proceeding leftward the expected monetary value at chance fork C_2 is calculated.

   Expected monetary value at C_2

   $$= 0.4 \times 0 + 0.3 \times 3.67 + 0.3 \times 15.13$$
   $$= \text{Rs } 0.564 \text{ million.}$$
5. Moving leftwards the first-stage decision point is reached. The alternatives and their expected monetary values, at this decision point, are:

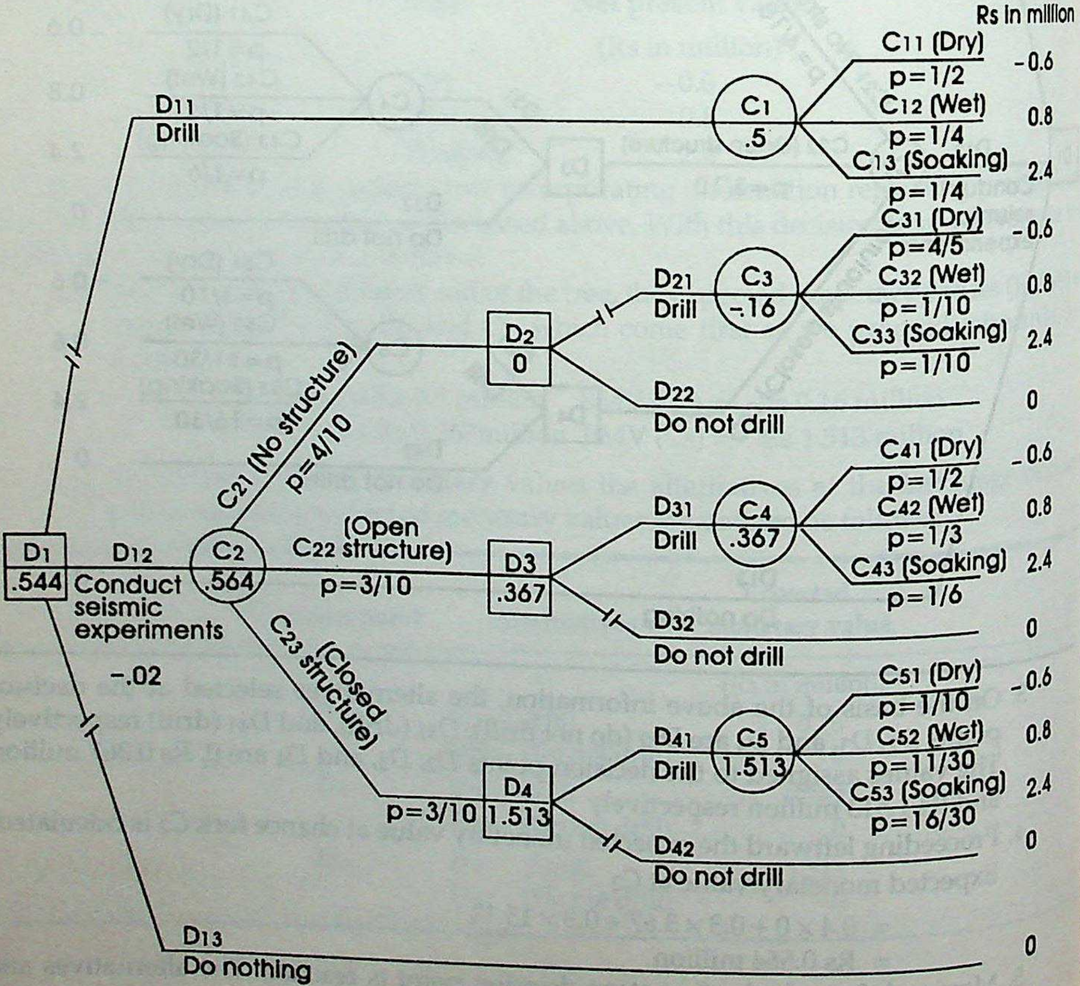
Alternatives	Expected monetary value (Rs in million)
D_{11} (Drill)	0.5
D_{12} (Conduct seismic experiments)	0.544
D_{13} (Do nothing)	0

Looking at the expected monetary values we find that D_{12} (conduct seismic experiments) is the most desirable alternative at the first stage decision point.

Exhibit 11.17 shows the decision tree with expected values at chance points and decision points.

EXHIBIT 11.17

Decision Tree


Rs in million
D1
.544
D11
Drill
D12
Conduct seismic experiments
-.02
D13
Do nothing
C1
.5
C11 (Dry)
p=1/2
C12 (Wet)
p=1/4
C13 (Soaking)
p=1/4
-0.6
0.8
2.4
C2
.564
C21 (No structure)
p=4/10
(Open C22 structure)
p=3/10
C23 (Closed structure)
p=3/10
D2
0
D21
Drill
C3
-.16
C31 (Dry)
p=4/5
C32 (Wet)
p=1/10
C33 (Soaking)
p=1/10
-0.6
0.8
2.4
D22
Do not drill
0
D3
.367
D31
Drill
C4
.367
C41 (Dry)
p=1/2
C42 (Wet)
p=1/3
C43 (Soaking)
p=1/6
-0.6
0.8
2.4
D32
Do not drill
0
D4
1.513
D41
Drill
C5
1.513
C51 (Dry)
p=1/10
C52 (Wet)
p=11/30
C53 (Soaking)
p=16/30
-0.6
0.8
2.4
D42
Do not drill
0
0

Based on the above evaluation of alternatives we find that the optimal decision strategy is as follows:

> Choose D_{12} (conduct seismic experiment) at decision point D_1 and wait for the outcome at chance point C_2. If the outcome at C_2 is C_{21} (no structure), then choose D_{22} (do not drill); if the outcome at C_2 is C_{22} (open structure), then choose D_{31} (drill); if the outcome at C_2 is C_{23} (closed structure), then choose D_{41} (drill).

Following the above decision strategy, the decision maker may, depending on the outcome at chance points, traverse paths as shown in Exhibit 11.18.

EXHIBIT 11.18

Paths, Probabilities, and Net Present Values

Path	Probability	Net present value
		Rs
$D_{12} \rightarrow C_{21} \rightarrow D_{22}$	0.40	– 20,000
$D_{12} \rightarrow C_{22} \rightarrow D_{31} \rightarrow C_{41}$	0.15	– 620,000
$D_{12} \rightarrow C_{22} \rightarrow D_{31} \rightarrow C_{42}$	0.10	780,000
$D_{12} \rightarrow C_{22} \rightarrow D_{31} \rightarrow C_{43}$	0.05	2,380,000
$D_{12} \rightarrow C_{23} \rightarrow D_{41} \rightarrow C_{51}$	0.03	– 620,000
$D_{12} \rightarrow C_{23} \rightarrow D_{41} \rightarrow C_{52}$	0.11	780,000
$D_{12} \rightarrow C_{23} \rightarrow D_{41} \rightarrow C_{53}$	0.16	2,380,000

The mean and standard deviation of the above distribution are:

$$\overline{NPV} = \text{Rs } 544{,}000, \quad \sigma(NPV) = \text{Rs } 1{,}044{,}367.$$

SELECTION OF A PROJECT

Given the information about expected return (measured as net present value, or internal rate of return, or some other criterion of merit) and variability of return (measured in terms of standard deviation or some other dispersion index), the next question is: Should the project be accepted or rejected?

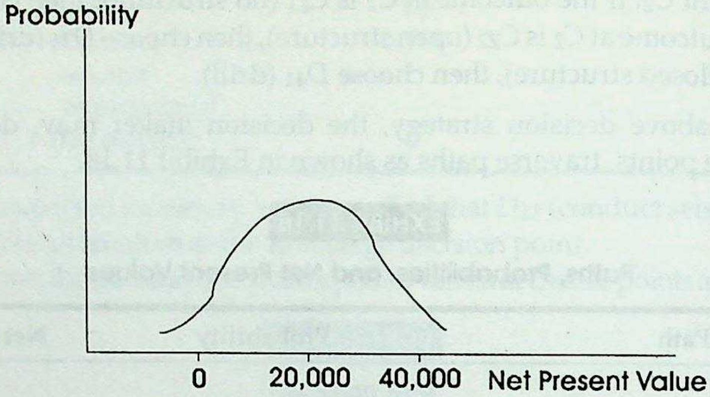
To decide whether the project should be accepted or rejected three methods may be suggested: the risk profile method, the certainty equivalent method, and the risk adjusted discount rate method.

Risk Profile Method

To use this method, we first transform the probability distribution of net present value, an absolute measure, into the probability distribution of profitability index, a relative measure. To illustrate this transformation, let us consider the probability distribution of net present value of a project, which involves an investment outlay of Rs 100,000, shown in Exhibit 11.19.

EXHIBIT 11.19

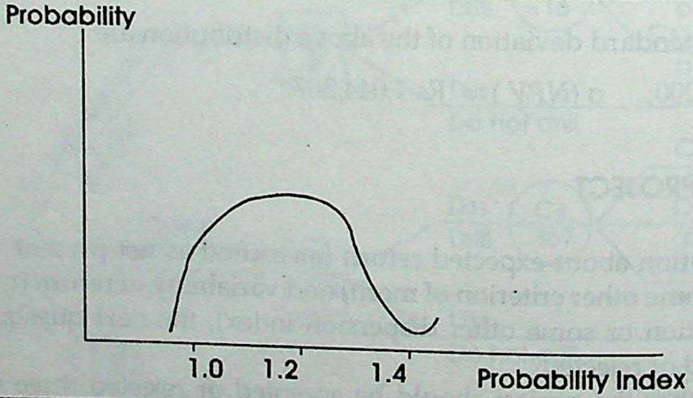
Probability Distribution of Net Present Value



Since profitability index is a linear transformation of net present value[5], the shape of its probability distribution is identical to that of the probability distribution of net present value. The probability distribution of profitability index for our project is shown in Exhibit 11.20. It should be noted that the x-axis of Exhibit 11.20 shows the profitability index values corresponding to the net present value shown on the x-axis of Exhibit 11.19.

EXHIBIT 11.20

Profitability Distribution of Profitability Index



Having transformed the probability distribution of net present value into the probability distribution of profitability index, we compare the dispersion of the profitability index of the project with the maximum risk profile acceptable to management for the expected profitability index of the project. Suppose the maximum risk profile acceptable to management when the expected profitability index is 1.20 is as shown in Exhibit 11.21.

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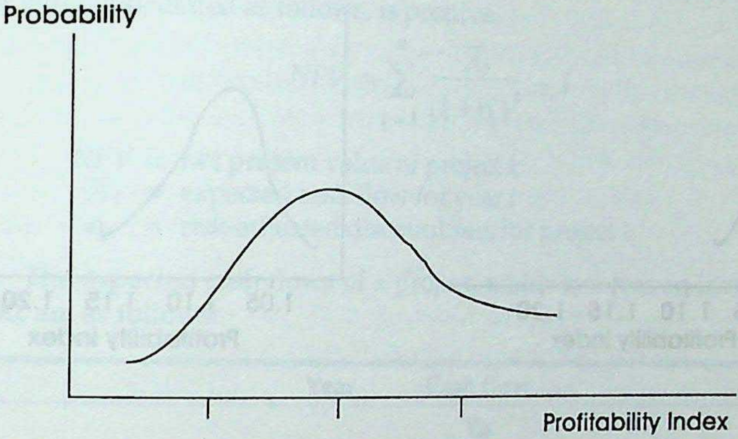
[5] Profitability index $= \frac{\text{Net present value + Investment}}{\text{Investment}}$

$$= \frac{\text{Net present value}}{\text{Investment}} + 1$$

Comparing the dispersions of the profitability index shown in Exhibits 11.20 and 11.21, we find that the risk of the project is less than the maximum risk acceptable to management for the given level of expected profitability index. Hence, the project is deemed worthwhile.

EXHIBIT 11.21

Maximum Risk Profile Acceptable when the Expected Profitability Index is 1.2



Several illustrative maximum risk profiles are shown in Exhibit 11.22. It may be noted that the higher the expected value of profitability index, the greater the dispersion that is acceptable to management. This is quite understandable. If the expected profitability index is high, the probability that the net present value is negative (profitability index is less than 1) is negligible even if the dispersion is wide. Another key factor that influences the maximum risk profile, of course, is the risk disposition of management. The higher the degree of managerial risk aversion, the greater the compactness of the maximum risk profile, given the expected value of profitability index.

Risk Adjusted Discount Rate Method

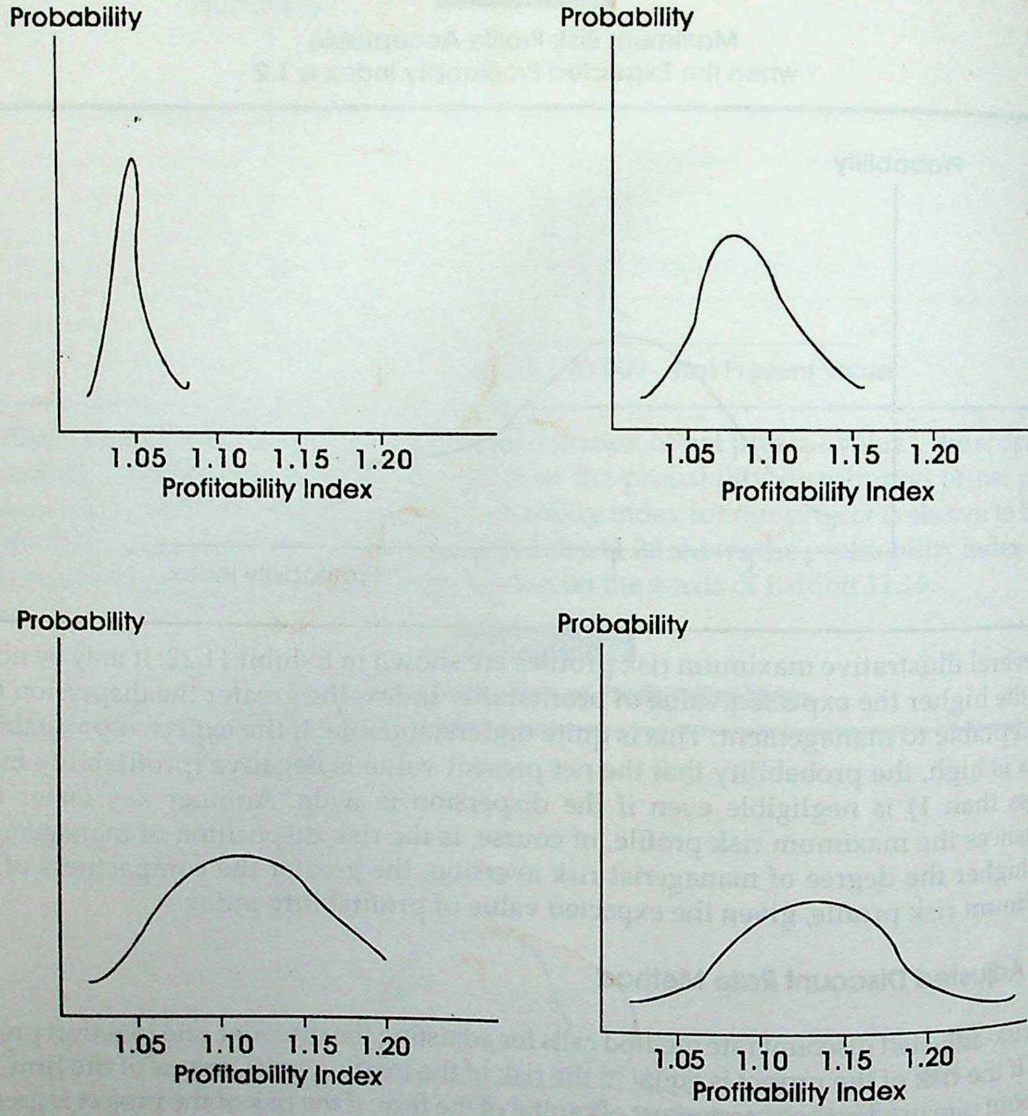
The risk-adjusted discount rate method calls for adjusting the discount rate to reflect project risk. If the risk of the project is equal to the risk of the existing investments of the firm, the discount rate used is the average cost of capital of the firm; if the risk of the project is greater than the risk of the existing investments of the firm, the discount rate used is higher than the average cost of capital of the firm; finally, if the risk of the project is less than the risk of the existing investments of the firm the discount rate used is less than the average cost of capital of the firm. The risk-adjusted discount rate is:

$$r_k = i + n + d_k \qquad (11.12)$$

where
r_k = risk-adjusted discount rate for project k
i = risk-free rate of interest
n = adjustment for the firm's normal risk
d_k = adjustment for the differential risk of project k

EXHIBIT 11.22

Illustrative Maximum Acceptable Risk Profiles



It may be noted that $(i + n)$ measures the firm's cost of capital. d_k may be positive or negative depending on how the risk of the project under consideration compares with the existing risk of the firm.

The adjustment for the differential risk of project k, quite understandably, depends on management's perception of the project risk and management's attitude towards risk (risk-return preference). A large pharmaceutical concern, for example, uses the following risk-adjusted discount rates for various types of investments.

Investment category	Risk-adjusted discount rate
Replacement investment	Cost of capital
Expansion investment	Cost of capital + 3%
Investments in related lines	Cost of capital + 6%
Investments in new lines	Cost of capital + 10%

Once the project's risk-adjusted discount rate (r_k) is specified, the project is accepted if its net present value, calculated as follows, is positive.

$$NPV = \sum_{t=1}^{n} \frac{\overline{A}_t}{(1+r_k)^t} - I \tag{11.13}$$

where NPV = net present value of project k

$\overline{A}_t$ = expected cash flow for year t

r_k = risk-adjusted discount rate for project k

Example The expected cash flows of a project, which involves an investment outlay of Rs 1,000,000, are as follows:

Year	Cash flow
	Rs
1	200,000
2	300,000
3	400,000
4	300,000
5	200,000

The risk-adjusted discount rate for this project is 18 per cent. Is the project worthwhile? The net present value of the project, using the risk-adjusted discount rate is:

$$\frac{200{,}000}{(1.18)} + \frac{300{,}000}{(1.18)^2} + \frac{400{,}000}{(1.18)^3} + \frac{300{,}000}{(1.18)^4} + \frac{200{,}000}{(1.18)^5} - 1{,}000{,}000 = -\text{ Rs } 129{,}440$$

Since the net present value is negative, the project is not worthwhile.

The risk-adjusted discount rate is commonly employed in practice. Firms use different discount rates, presumably related to the factor of risk, for different types of investment projects. The discount rate is generally low for routine replacement investments, moderate for expansion investments, and high for new investments.

Despite its popularity, the risk-adjusted discount rate method suffers from two serious limitations: (i) It is difficult to estimate d_k consistently—often it is determined in an ad hoc and arbitrary manner. (ii) This method assumes that risk increases with time *at a constant rate*. This assumption may not be very valid.

Certainty Equivalent Method

Before describing the certainty equivalent method let us understand the concept of certainty equivalent coefficient. Suppose someone presents you with a lottery the outcome of which has the following probability distribution.

Outcome	Probability
Rs 1,000	0.3
Rs 5,000	0.7

You are further asked: How much of a certain amount would you accept in lieu of this lottery? Let us say that your reply is: Rs 3,000. This amount—Rs 3,000—represents the certainty equivalent of the above lottery which has an expected value of Rs 3,800 (Rs 1,000 × 0.3 + Rs 5,000 × 0.7) and a given distribution. The factor 3,000 / 3,800 (= 0.79) is called the certainty equivalent coefficient. It reflects primarily two things: variability of the outcomes and your attitude towards risk. Certainty equivalent coefficients transform expected values of uncertain flows into their certainty equivalents.

Under the certainty equivalent method the net present value is calculated as follows:

$$NPV = \sum_{t=1}^{n} \frac{\alpha_t \overline{A}_t}{(1+i)^t} - I \tag{11.14}$$

where NPV = net present value
$\overline{A}_t$ = expected cash flow for year t
t = certainty equivalent coefficient for the cash flow of year t
i = risk-free interest rate
I = initial investment (about which it is assumed that there is no uncertainty)

Example Vazeer Hydraulics Limited is considering an investment proposal involving an outlay of Rs 4,500,000. The expected cash flows and certainty equivalent coefficients are:

Year	Expected cash flow	Certainty equivalent coefficient
	Rs	
1	1,000,000	0.90
2	1,500,000	0.85
3	2,000,000	0.82
4	2,500,000	0.78

The risk-free interest rate is 5 per cent. Calculate the net present value of the proposal. The net present value is equal to:

$$\frac{1{,}000{,}000\ (0.90)}{(1.05)} + \frac{1{,}500{,}000(0.85)}{(1.05)^2} + \frac{2{,}000{,}000\ (0.82)}{(1.05)^3} + \frac{2{,}500{,}000(0.78)}{(1.05)^4} - 4{,}500{,}000$$

$= \text{Rs } 534{,}570$

The value of the certainty equivalent coefficient usually ranges between 0 and 1. A value of 1 implies that the cash flow is certain or the management is risk neutral. In industrial situations, however, cash flows are generally uncertain and managements usually risk-averse. Hence the certainty equivalent coefficients are typically less than 1. An illustrative table of certainty equivalent coefficients for different types of investments is shown here.

	Certainty equivalent coefficients			
	Year 1	*Year 2*	*Year 3*	*Year 4*
Replacement investment	0.92	0.87	0.84	0.80
Expansion investment	0.89	0.85	0.80	0.75
New product investment	0.85	0.80	0.74	0.68
Research and development investment	0.75	0.70	0.64	0.58

The certainty equivalent method is conceptually superior to the risk-adjusted discount rate method because it does not assume that risk increases with time at a constant rate. Each year's certainty equivalent coefficient is based on the level of risk characterising its cash flow. Despite its conceptual superiority it is not as popular as the risk-adjusted discount rate method. This is perhaps because it is inconvenient and difficult to specify a series of certainty equivalent coefficients but seemingly simple to adjust the discount rate. Notwithstanding this practical difficulty, the merits of the certainty equivalent method must not be ignored.

RISK ANALYSIS IN PRACTICE

Several methods to incorporate the risk factor into capital expenditure analysis are used in practice. The most common ones are discussed here.

Conservative Estimation of Revenues

In many cases the revenues expected from a project are conservatively estimated to ensure that the viability of the proposed project is not easily threatened by unfavourable circumstances. The capital budgeting systems often have built-in devices for conservative estimation. This is indicated by the following remarks made by two executives:

> We ask the project sponsor to estimate revenues conservatively. This checks the optimism common among project sponsors.
>
> The capital budgeting committee requires justification for revenue figures given by those who propose capital expenditures. This has a sobering effect on them.

Safety Margin in Cost Figures

A margin of safety is generally included in estimating cost figures. This varies between 10 per cent and 30 per cent of what is deemed as normal cost. The size of the margin depends on what management feels about the likely variation in cost. The following observation points towards this:

> In estimating the cost of raw material we add about 20 to 25 per cent to the current prices as the raw material price is not stable and often we pay a high price to get it. For labour cost we add about 10 to 12 per cent as this is the annual increase.

Flexible Investment Yardsticks

The cut-off point on an investment varies according to the judgement of management about the riskiness of the project. In one company replacement investments are okayed if the expected post-tax return exceeds 15 per cent but new investments are undertaken only if the expected post-tax return is greater than 20 per cent. Another company employs a short pay back period of three years for new investments. Its decision rules were stated by its financial controller as follows:

> Our policy is to accept a new project only if it has a pay back period of three years. We have never, as far as I know, deviated from this. The use of a short pay back period automatically weeds out risky projects.

Acceptable Overall Certainty Index

Some companies calculate what may be called the overall certainty index, based on a few crucial factors affecting the success of the project.

The calculation of an overall certainty index may be illustrated by an example drawn from a large engineering concern. The overall certainty index for a capital expenditure considered by this firm was calculated as follows:

	Certainty index %
Raw material availability	70
Power availability	60
Freedom from competition	80
Overall certainty index	$= \dfrac{70+60+80}{3} = 70$

This company accepted the project because it regarded a 70 per cent level of overall certainty as satisfactory.

Judgement on Three Point Estimates

In some companies three estimates are developed for one or more aspects of the proposed investments. The top management or the board of directors decides on the basis of such information. Two examples of this are given below:

- In a pharmaceutical company project sponsors are required to give three estimates of rate of return; most pessimistic, most likely, and most optimistic.
- In a shipping company three estimates, labelled high, medium, and low respectively, are developed for proposed acquisitions.

Evaluation

The methods of conservative estimation of revenues, safety margin in cost figures, and flexible investment yardsticks, in common practice, do not generally employ explicitly defined probability distribution. They are based on subjective, implicit evaluation. The three-point estimates method is based on three points in the range of variation and provides some idea of probability distribution. The overall certainty index method is based on two-level discrete probability distribution of important factors affecting the outcome of investment. However, the manner in which these probabilities are used for developing the overall certainty index of a project whose success is dependent on the attainment of three states A, B, and C, is $p\,(A) \times p\,(B/A) \times p\,(C/A \text{ and } B)$ and not $[\,p\,(A) + p\,(B) + p\,(C)\,]/3$ as defined by the overall certainty index method used in practice.

Room for Improvement

A significant improvement in the analysis of the risk factor in practice can be brought about if probability distributions of the key factors underlying investments are developed and information is communicated in this form. This means the use of (i) subjectively understood phrases like the 'most likely return', and 'low chances of failure', and (ii) single point estimates, will have to be replaced by probability distributions. This has certain advantages.

1. It would alleviate ambiguity in communication. When judgements about uncertainty are transmitted in qualitative phrases they are likely to be interpreted in a sense different from what the communicator has in mind because of the vagueness of communication. Such vagueness is reduced if judgements are quantified in terms of probability distribution.
2. It would reduce bias in reporting. When managers and other informants are asked to provide single-point estimates (a common practice) they often tend to under-estimate revenues and over-estimate costs when performance evaluation emphasises negative variations. If there is no performance evaluation revenues may be over estimated and costs underestimated for projecting a favourable picture of a project. Such tendencies may be checked to some extent if managers and other informants are asked to provide probability distribution instead of single point estimates.
3. It utilises more information. When an expert, say a market analyst, is asked to give an estimate of market demand in terms of a single number, he has to necessarily discard a good deal of his knowledge about the market which otherwise can be communicated in the form of a probability distribution.
4. It is convenient. With experience it is easy to express judgements in probabilistic terms than in terms of a single-point estimate. Often experts find it convenient to communicate their judgement in terms of probability distribution rather than in the form of a single-point estimate.

SUMMARY

- Risk analysis of capital investments is one of the most complex, controversial, and slippery areas in finance.
- Risk refers to variability. Several measures of variability have been used to denote risk. The important ones are: range, mean absolute deviation, standard deviation, coefficient of variation, and semi-variance. Out of these measures, standard deviation is most commonly used in financial theory.

- To assess the risk of a project several methods are available: analytical derivation, sensitivity analysis, scenario analysis, simulation analysis, and decision tree analysis.
- Under certain circumstances, the expected net present value and the standard deviation of net present value may be obtained by mathematical analysis. Three cases of such analysis have been discussed: no correlation among cash flows; perfect correlation among cash flows; and moderate correlation among cash flows.
- Knowledge of expected net present value and standard deviation of net present value is very useful in evaluating the risk characteristics of a project. Given this information, if the net present value of the project is approximately normally distributed, we can calculate the probability of net present value being less than or more than a certain specified value.
- Sensitivity analysis, sometimes called *'what if'* analysis, answers questions such as: What will happen to net present value (or some other criterion of merit) if sales are only 50,000 units rather than the expected 75,000 units?
- Scenario analysis looks at some plausible scenarios (each scenario representing a certain configuration of key variables) and examines how the net present value (or some other criterion of merit) behaves.
- Monte Carlo simulation, when applied to study project risk, helps in generating a simulated probability distribution of net present value or any other criterion of merit. A flexible and versatile tool, simulation is a useful tool.
- Decision tree analysis is a technique for analysing situations where sequential decision-making in the face of risk is involved.
- To decide whether a project should be accepted or rejected, once information about its risk characteristics is available, three methods may be suggested: (i) the risk profile method, (ii) the certainty equivalent method, and (iii) the risk-adjusted discount rate method.
- Under the risk profile method, the probability distribution of net present value, an absolute measure, is transformed into the probability distribution of profitability index, a relative measure. Then, the dispersion of the profitability index is compared with the maximum risk profile acceptable to management for the expected profitability index of the project.
- The risk adjusted discount rate method calls for suitably adjusting the discount rate to reflect the risk of the project.
- Under the certainty equivalent method, the expected cash flows are transformed into their certainty equivalents by applying suitable certainty equivalent coefficients. Then, the risk-free interest is applied for discounting purposes.
- The methods of risk analysis commonly used in practice are: (i) conservative estimation of revenues, (ii) safety margin in cost figures, (iii) flexible investment yardsticks, (iv) acceptable overall certainty index, and (v) judgement on three-point estimates.
- The analysis of risk factor in practice can be improved if the probability distributions of the key factors underlying an investment project are developed and information is communicated in this form.

QUESTIONS

1. Describe the three types of project risk.
2. Illustrate the difference between variance and semi-variance with an example.
3. What is $\sigma(NPV)$ when there is (a) no correlation among cash flows and (b) perfect correlation among cash flows.
4. If the *NPV* of a project is normally distributed, how would you calculate the probability of *NPV* being less than zero?
5. Briefly describe the procedure of sensitivity analysis.
6. Evaluate sensitivity analysis as a method for assessing risk.
7. Discuss what is scenario analysis.
8. Explain the key steps involved in Monte Carlo simulation.
9. Discuss the approaches used for obtaining probability distributions of the basic variables.
10. Comment on the problem of correlation in Monte Carlo simulation.
11. Substantiate the issues in the application of Monte Carlo simulation and the ways and means of resolving them.
12. What are the pros and cons of Monte Carlo simulation.
13. Delineate the key steps involved in decision tree analysis.
14. Discuss the risk profile method.
15. Explain the risk adjusted discount rate method.
16. Describe the certainty equivalent method.
17. Critically comment on the methods of risk analysis used in practice.

PROBLEMS

1. The probability distribution of the outcome of an investment is shown below:

Outcome	**Probability**
Rs	
1,000	0.1
2,000	0.3
3,000	0.4
4,000	0.2

Calculate the following measures of dispersion.

(i) Range
(ii) Mean absolute deviation
(iii) Standard deviation
(iv) Coefficient of variation
(v) Semi-variance

2. A project involving an outlay of Rs 1 million has the following benefits associated with it.

Year 1		Year 2		Year 3	
Cash flow (Rs in million)	*Probability*	*Cash flow (Rs in million)*	*Probability*	*Cash flow (Rs in million)*	*Probability*
0.4	0.4	0.5	0.4	0.3	0.3
0.5	0.5	0.6	0.4	0.4	0.5
0.6	0.1	0.7	0.2	0.5	0.2

Assume that the cash flows are independent. Calculate the expected net present value and the standard deviation of net present value assuming that $i = 10$ per cent.

3. Janakiram is considering an investment which requires a current outlay of Rs 25,000. The expected value and standard deviation of cash flows are:

Year	**Expected value**	**Standard deviation**
	Rs	Rs
1	12,000	5,000
2	10,000	6,000
3	9,000	5,000
4	8,000	6,000

The cash flows are perfectly correlated. Calculate the expected net present value and standard deviation of net present value of this investment, if the risk-free interest rate is 8 per cent.

4. Ujwal Lamps Company is evaluating an investment project which has an estimated life of four years. The cost of the project is Rs 10,000 and the possible cash flows are given below:

Year 1		Year 2		Year 3		Year 4	
Cash flow	*Probability*	*Cash flow*	*Probability*	*Cash flow*	*Probability*	*Cash flow*	*Probability*
2,000	0.2	3,000	0.4	4,000	0.3	2,000	0.2
3,000	0.5	4,000	0.3	5,000	0.5	3,000	0.4
4,000	0.3	5,000	0.3	6,000	0.2	4,000	0.4

The cash flows of various years are independent and the risk-free discount rate (post-tax) is 6 per cent.

(i) What is the expected net present value?

(ii) If the *NPV* is approximately normally distributed, what is the probability that the *NPV* will be zero or less?

(iii) What is the probability that the profitability index will be greater than 1.2?

5. Dhanwantari Limited is looking at a proposal to manufacture a new pharmaceutical preparation which has a life of three years. The cash flow of year 2 is dependent on the cash flow of year 1; the cash flow of year 3 is dependent on the cash flows of years 1 and 2. The cash flow distribution is as follows:

Year 1		Year 2		Year 3	
Cash flow	*Probability*	*Cash flow*	*Probability*	*Cash flow*	*Probability*
				40,000	0.7
		60,000	0.6	50,000	0.3
50,000	0.4	80,000	0.4	60,000	0.6
				70,000	0.4
				80,000	0.3
				90,000	0.7
80,000	0.6	90,000	0.8	100,000	0.8
		100,000	0.2	110,000	0.2

The project costs Rs 150,000 and the risk-free rate of interest (post-tax) is 5 per cent.

(i) What is the expected *NPV*?

(ii) What is the standard deviation of *NPV*?

6. Bidhan Corporation is considering the risk characteristics of a project. The firm has identified that the following factors have a bearing on the *NPV* of this project:

Initial investment	(I)
Cost of capital	(k)
Quantity manufactured and sold annually	(Q)
Price per unit	(P)
Variable cost per unit	(V)
Fixed costs	(F)
Depreciation	(D)
Tax rate	(T)
Life of the project	(n)
Net salvage value	(S)

The relationship between these factors and *NPV* is as follows:

$$NPV = \sum_{t=1}^{n} \frac{Q[(P-V) - F - D](1-T) + D}{(1+k)^t} + \frac{S}{(1+k)^n} - I$$

The management of the firm feels that I, k, F, D, T, n, and S, not subject to much variation, may be deemed as constant at the following levels:

$I = 30{,}000$

$k = 10$ per cent

$F = 3{,}000$

$D = 2{,}000$*

$T = 0.5$

$n = 5$

$S = 0$

---

* For the sake of simplicity depreciation has been calculated as per the straight line method.

The probability distribution for *Q*, *P*, and *V* have been defined as follows:

Q		P		V	
Value	*Probability*	*Value*	*Probability*	*Value*	*Probability*
800	0.10	20	0.4	15	0.3
1000	0.10	30	0.4	20	0.5
1200	0.20	40	0.1	40	0.2
1400	0.30	50	0.1		
1600	0.20				
1800	0.10				

(i) Using a random number table, obtain 50 simulated values of *NPV*.

(ii) Calculate the mean and standard deviation from the simulated values.

7. Consider the data given in problem 6. Carry out sensitivity analysis with reference to quantity (*Q*) and price (*P*).
8. After carefully assessing the risk-preference of its management, the Tristar Shipping Company has determined the maximum risk profiles—these show the maximum standard deviation of profitability acceptable for a particular expected value of profitability index. The maximum risk profiles are:

Expected profitability index	Maximum Standard deviation
1.00	0.00
1.05	0.03
1.10	0.08
1.15	0.16
1.20	0.25
1.25	0.30

The company is considering an investment proposal involving an outlay of Rs 5 million. The distribution of net present value for this investment is as follows:

Net present value	Probability
(Rs in million)	
0.5	0.02
0.0	0.03
0.5	0.10
1.0	0.40
1.5	0.30
2.0	0.15

Should the company accept the investment proposal?

9. Kejriwal Company is considering two mutually exclusive investments, *A* and *B*. Investment *A* requires an outlay of Rs 10,000 and generates a net cash flow of Rs 3,000 for six years. Investment *B* requires an outlay of Rs 30,000 and generates a net cash flow of Rs 11,000 for

five years. The required rates of return on these investments are 12 per cent (for A) and 14 per cent (for B). Which of the two should the firm choose?

10. The expected cash flows of a project are given below:

Year	Cash flow
	Rs
0	(30,000)
1	7,000
2	8,000
3	9,000
4	10,000
5	8,000

The certainty equivalent factor behaves as per the following equation:

$$\alpha_t = 1 - 0.06\,t$$

Calculate the net present value of the project if the risk-free rate of return is 8 per cent.

11. A wildcatter must decide whether to drill or not to drill in a certain basin. He is uncertain whether the well will be dry (D), wet(W), or soaking (S). His payoffs in terms of *NPV* are given below:

State	Act	
	Drill	Don't drill
D	Rs 80,000	0
W	60,000	0
S	250,000	0

The wildcatter can use a crude seismic experiment which will give an indication of the geological characteristics of the sub-surface structure, before making his final decision. The crude experiment costs Rs 3,000 and is somewhat unreliable. The relationship between the true subsurface structure and the subsurface structure indicated by this experiment is as follows:

True sub-surface structure	**Indicated sub-surface structure**		
	No structure	*Open structure*	*Closed structure*
No structure	0.80	0.20	0.00
Open structure	0.25	0.65	0.10
Closed structure	0.15	0.25	0.60

The relationship between the geological subsurface structure and the oil bearing condition of the well is given below:

State	Geological sub-surface structure			
	No structure	*Open structure*	*Closed structure*	*Marginal probability of state*
Dry	0.30	0.15	0.05	0.50
Wet	0.09	0.12	0.04	0.25
Soaking	0.01	0.03	0.21	0.25
Marginal probability of geological sub-surface structure	0.40	0.30	0.30	1.00

Portray this investment decision situation in terms of a decision tree diagram indicating the probability of all outcomes. Determine the optimal decision strategy using the expected *NPV* criterion. What is the variance of *NPV*?

APPENDIX 11A

RULES RELATING TO EXPECTED VALUES AND VARIANCES

Certain rules relating to expected values and variances are given below.

Rule 1 If c is a constant, its expected value is c.

This is because a constant is a degenerate random variable which always takes the same value, the expected value.

Rule 2 If c is a constant and Y a random variable, then

$$E(cY) = cE(Y) \tag{11A.1}$$

This is because

$$E(cY) = \sum cY_i p(Y_i) = c\sum Y_i p(Y_i)$$
$$= cE(Y)$$

Rule 3 If a and b are constants and Y a random variable, then

$$E(a + bY) = a + bE(Y) \tag{11A.2}$$

This can be obtained by combining rules 1 and 2.

Rule 4 If X and Y are random variables

$$E(X+Y) = E(X) + E(Y) \tag{11A.3}$$

This is because

$$\begin{aligned}
E(X+Y) &= \sum_{-\infty \le i, j \le \infty} (X_i + Y_j)\, p(X_i, Y_j) \\
&= \sum_i \sum_j X_i\, p(X_i, Y_j) \\
&\quad + \sum_j \sum_i Y_j\, p(X_i, Y_j) \\
&= \sum_i X_i \sum_j p(X_i, Y_j) \\
&= \sum_j Y_j \sum_i p(X_i, Y_j) \\
&= \sum_i X_i\, p(X_i) + \sum_j Y_j\, p(Y_j) \\
&= E(X) + E(Y)
\end{aligned}$$

The generalised form of this rule is

$$E(X_1 + X_2 + X_3 + \ldots + X_n)$$
$$= E(X_1) + E(X_2) + \ldots E(X_n) \tag{11A.4}$$

Rule 5 If *c* is a constant, its variance is zero.

This is again because a constant is a degenerate random variable which always takes the same value, the expected value. Hence the deviation is always zero, making variance zero.

Rule 6 If *c* is a constant and *Y* a random variable then

$$\text{Var}\ (cY) = c^2\ \text{Var}\ (Y) \tag{11A.5}$$

This is because

$$\begin{aligned}
\text{Var}\ (cY) &= E\ [(cY) - E\ (cY)]^2 \\
&= E\ [(cY - cE\ (Y))]^2 \\
&= E\ [c\{Y - E(Y)\}]^2 \\
&= c^2 E[Y - E\ (Y)]^2 \\
&= c^2\ \text{Var}\ (Y)
\end{aligned}$$

Rule 7 If *a* and *b* are constants and *Y* a random variable then

$$\text{Var}\ (a + bY) = b^2\ \text{Var}(Y) \tag{11A.6}$$

This can be obtained by combining rules 5 and 6.

Rule 8 If *X* and *Y* are random variables, then

$$\text{Var}(X+Y) = \text{Var}(X) + \text{Var}(Y) + 2\ \text{Cov}(X, Y) \tag{11A.7}$$

This is because

$$\begin{aligned}
\text{Var}\ (X+Y) &= E[X + Y - E(X+Y)]^2 \\
&= E[X + Y - E(X) - E(Y)]^2 \\
&= E[X - E(X) + Y - E(Y)]^2 \\
&= E[\{X - E(X)\} + \{Y - E(Y)\}]^2 \\
&= E[X - E(X)]^2 + E[Y - E(Y)]^2 \\
&\quad + 2E[X - E(X)]\ [Y - E(Y)] \\
&= \text{Var}(X) + \text{Var}(Y) + 2\ \text{Cov}(X, Y)
\end{aligned}$$

The generalised form of this rule is

$$\begin{aligned}
&\text{Var}(X_1 + X_2 + \ldots + X_n) \\
&= \text{Var}(X_1) + \text{Var}(X_2) + \ldots + \text{Var}(X_n) \\
&\quad + 2\,\text{Cov}(X_1, X_2) + 2\,\text{Cov}(X_1, X_3) + \\
&\quad \ldots + 2\,\text{Cov}(X_{n-1}, X_n) \\
&= \sum_{t=1}^{n} \text{Var}(X_1) \\
&\quad + 2 \sum_{j<t}^{n} \sum_{i}^{n} \text{Cov}(X_i, X_j)
\end{aligned} \tag{11A.8}$$

APPENDIX 11B

APPLIED UTILITY THEORY

If the risk attitude of top management (the group that often makes decisions regarding investments) can be translated into a utility curve, the risk factor can be incorporated in the final decision in a fairly simple and consistent manner.

A utility function describes a person's risk attitude just as subjective probabilities describe a person's judgement about probabilities. The utility function shows the utiles (an arbitrary measure of satisfaction) associated with different monetary outcomes. Normally utiles are shown on the vertical axis and monetary returns are shown on the horizontal axis. An illustrative utility function is given in Exhibit 11B.1.

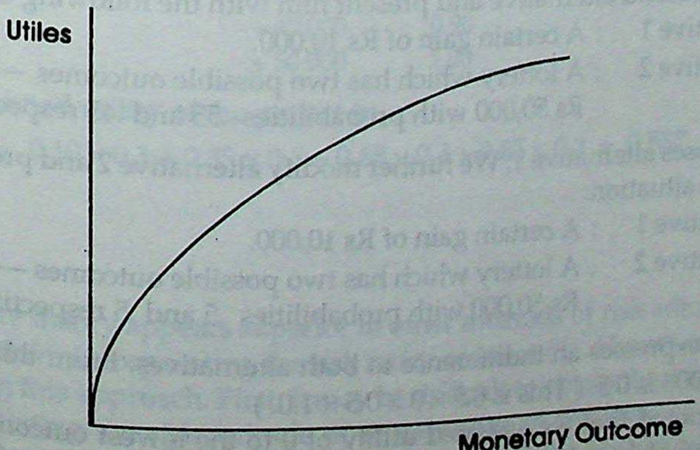
OBTAINING THE UTILITY FUNCTION

How can a person's utility function be obtained? Neumann and Morgenstern[1] have suggested a method which is as follows:

1. Find the range of monetary outcomes that a person regards as relevant. The end points of this range may be designated as *A* and *B*.

EXHIBIT 11B.1

Utility Function



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[1] J. Von Neumann and O. Morgenstern, *Theory of Games and Economic Behaviour*, Princeton, N.J: Princeton University Press, 1944.

2. Assign a utility of 0 to A (the lowest outcome) and a utility of 1 to B (the highest outcome).
3. Determine the utility associated with any intermediate value by the following process:
   (i) Present the individual with two alternatives. The first alternative consists of the intermediate value X, the utility of which is to be determined. The second alternative consists of a lottery which has two possible outcomes, A and B, with probabilities p_1 and p_2 attached to them ($p_1 + p_2$).
   (ii) Ask the individual to choose one of the alternatives presented in (i) above.
   (iii) If the individual chooses the first alternative, revise the second alternative such that it becomes more attractive. This means the value of p_2 should be increased. If the individual chooses the second alternative, revise it such that it becomes less attractive. This means the value of p_2 should be decreased and the value of p_1 should be increased.
   (iv) Ask the individual to choose after the revision of lottery as per step (iii). Continue this till the individual becomes indifferent to both alternatives.
   (v) When the individual becomes indifferent to both alternatives the utility of X is simply the value of p_2.
4. Obtain the utility values of several intermediate outcomes and plot the utility function.

An example may be given to illustrate the above procedure. The relevant range for an individual is —Rs 10,000 and Rs 50,000. The utility of —Rs 10,000 is put as 0 and that of Rs 50,000 is put as 1. We wish to find the individual's utility for Rs 10,000. We present him with two alternatives:

Alternative 1 : A certain gain of Rs 10,000.
Alternative 2 : A lottery which has two possible outcomes —Rs 10,000 and Rs 50,000 with probabilities 0.6 and 0.4 respectively.

We ask him to choose between the two alternatives. He chooses, say, alternative 1. We now modify the second alternative and present him with the following choice situation:

Alternative 1 : A certain gain of Rs.10,000.
Alternative 2 : A lottery which has two possible outcomes — Rs 10,000 and Rs 50,000 with probabilities .55 and .45 respectively.

He again chooses alternative 1. We further modify alternative 2 and present him with the following choice situation:

Alternative 1 : A certain gain of Rs 10,000.
Alternative 2 : A lottery which has two possible outcomes — Rs 10,000 and Rs 50,000 with probabilities .5 and .5 respectively.

This time he expresses an indifference to both alternatives. From this we infer that his utility for Rs 10,000 is 0.5. (This is $0.5 \times 0 \times 0.5 \times 1.0$.)

It should be noted that we assigned utility of 0 to the lowest outcome (of the relevant range) and utility of 1 to the highest outcome (of the relevant range). These values were chosen arbitrarily. We could choose any other set of values, say 1 and 10 or −12 1/2 and

11 1/3. The point to note is that there is no sanctity attached to any set of values because the utility function is unique up to a linear transformation.

Once the utility curve of the decision making unit is obtained the expected utility of a project is measured as follows:

1. Define the probability distribution of *NPV*.
2. Calculate the expected utility by using Eq. (11B.1).

$$\sum U\,(NPV_i)\,p_i \tag{11B.1}$$

where $U\,(NPV_i)$ = utility of the *i*th possible *NPV*

p_i = probability of *i*th possible outcome

A numerical example may be given to illustrate the nature of calculation. Let the probability distribution of the *NPV* for a project be as follows:

NPV	Probability
Rs	
– 10,000	0.1
0	0.3
+ 20,000	0.4
+ 30,000	0.2

Let the utility for money for the decision maker be as follows:

Money	Utility
Rs	
– 20,000	0
– 10,000	0.10
0	0.35
+ 10,000	0.50
+ 20,000	0.68
+ 30,000	0.85
+ 40,000	0.90
+ 50,000	1.00

Hence the expected utility of the project is:

$$0.10 \times 0.1 + 0.35 \times 0.3 + 0.68 \times 0.4 + 0.85 \times 0.2 = 0.557$$

EVALUATION

The applied utility theory appears superior to other methods of risk adjustment because it offers an approach for incorporating the risk factor consistently. However, there are certain problems in using this approach. First, it may be difficult to obtain the utility function of an individual. Translating the risk attitude of an executive in the form of a utility function realistically requires patience and ingenuity on the part of the analyst and understanding and trust on the part of the decision maker. As a rule, checks for consistency are required after the first plot of the utility function is obtained. Modifications should be made on the basis of additional probing till the decision maker is confident that the utility function represents his attitude towards risk. Second, the utility function of the decision maker may not remain stable over time since it is dependent on the organisation's financial position. (We are here presuming that the decision maker acts on behalf of his organisation.) Third, there is no generally acceptable way of determining the utility function of a group. (Note that many important investment decisions are group decisions.)

In view of the above problems, the utility theory does not seem to be very useful, particularly for investment decisions where the costs and benefits are spread over a fairly long time period and where the time of resolution of uncertainty is usually a very important consideration. It is, however, a potential tool for short-term investment decisions. John S. Hammond III, an advocate of the utility theory, says:

> By isolating attitude toward risk from the other aspects of a complex decision problem and eliciting the attitude by simple questions, we force the decision maker to be far more explicit about his attitude than he has ever been.[2]

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[2] John S. Hammond III, 'Better Decisions with Preference Theory', *Harvard Business Review*, Nov-Dec, 1967.

APPENDIX 11C

A SIMULATION MODEL FOR CAPITAL BUDGETING

In Chapter 11, a simplified simulation model for capital budgeting was presented. A comparatively more elaborate (and hopefully more realistic) simulation model for capital budgeting is described in this appendix.

MODEL

The parameters, exogenous variables, endogenous variables, and identities and equations of the model are as follows:

Parameters

i = risk free interest rate
DR = depreciation rate
TAX = tax rate
O_1 = output in year 1
= the annual rate of increase in the ratio of net salvage value to book value.

Exogenous Variables

INV = investment at the beginning
g_t = rate of output growth in year t
N = life of the project
SP_t = selling price per unit in year t
TFC_t = total fixed costs in year t
UVC_t = unit variable cost in year t

Endogeneous Variables

BV_t = book value of investment at the end of year t
O_t = output in year t
QS_t = quantity sold in year t
REV_t = revenues for year t
DEP_t = depreciation charge in year t
TVC_t = total variable cost in year t

TFC_t = total fixed cost in year t
TC_t = total cost in year t
PBT_t = profit before tax in year t
PAT_t = profit after tax in year t
NCF_t = net cash flow from operations in year t
NSV_t net salvage value at the end of year t
NPV_m net present value of the project on the mth simulation run.

Identities and Equations

$$BV_0 = INV \tag{11C.1}$$

$$BV_t = BV_0 (1 - DR)^t \tag{11C.2}$$

$$DEP_t = BV_0 (1 - DR)^{t-1} \, DR \tag{11C.3}$$

$$QS_t = O_t \tag{11C.4}$$

$$O_t = O_1 \mathop{\pi}\limits_{\tau=2}^{t} (1 + g_\tau) \tag{11C.5}$$

$$REV_t = (QS_t)\ (SP_t) \tag{11C.6}$$

$$TC_t = TFC_t + TCV_t \tag{11C.7}$$

$$TVC_t = (O_t)\ (UVC_t) \tag{11C.8}$$

$$PBT_t = REV_t - TC_t - DEP_t \tag{11C.9}$$

$$PAT_t = (REV_t - TC_t - DEP_t)\ (1 - TAX) \tag{11C.10}$$

$$NCF_t = PAT_t + DEP_t \tag{11C.11}$$

$$NSV_t = BV_t\ (1 + \alpha)^t \tag{11C.12}$$

$$NPV_m = \sum_{t=1}^{N} \frac{NCF_t}{(1+i)^t} + \frac{NSV_N}{(1+i)^N} - INV \tag{11C.13}$$

APPENDIX 11D

PROBABILITY DISTRIBUTIONS IN MONTE CARLO ANALYSIS

Defining probability distributions for the variables is a very critical element of risk analysis. It is also regarded as one of the most troublesome aspects of risk analysis. Perhaps this stems from the belief that risk analysis requires the true distribution of each variable. This indeed may be quite impossible because the true distribution usually is not known. Hence from a practical point of view, the aim of risk analysis has to be necessarily more modest. It should be based on distributions which represent the best judgement of the experts rather than true distributions which are often unknown. In this context we may ask: How useful are certain distributions in reflecting expert judgements? To answer this question, we will look at the following distributions and consider their utility:

- Uniform distribution
- Trapezoidal distribution
- Triangular distribution
- Beta distribution
- Normal distribution

(These distributions are shown graphically in Exhibit 11D.1.)

Uniform Distribution

This distribution may be employed where the expert, because of vagueness in his judgement, is unable to differentiate between values within the range of the variable. Such a distribution, however, makes very little sense. For example, it may be absurd to claim that the project has an equal probability of costing anywhere between Rs 20 million and Rs 30 million, but will not under any circumstance cost Rs 19.99 million or Rs 30.01 million. Hence, the uniform distribution should be used only for variables which are not critical or when the appraiser wants to play safe by over-estimating the probability of extreme values in the range of the variables.

Trapezoidal Distribution

Under normal circumstances, a variable lies in a small range around its best estimate. Under unusual circumstances, of course, it may fall outside this range. However, the likelihood of a value tends to diminish the farther the value is from the range in which it would normally fall. The trapezoidal distribution represents these possibilities rather well. Hence, it appears to reflect a large class of subjective judgements quite satisfactorily.

Triangular Distribution

This distribution assumes that the probability of a value declines as the value deviates from the best estimate. Clearly this is a particular case of the trapezoidal distribution. It is appropriate when the expert has great confidence in his best estimate. Otherwise, the trapezoidal distribution is preferable to this distribution.

Beta Distribution

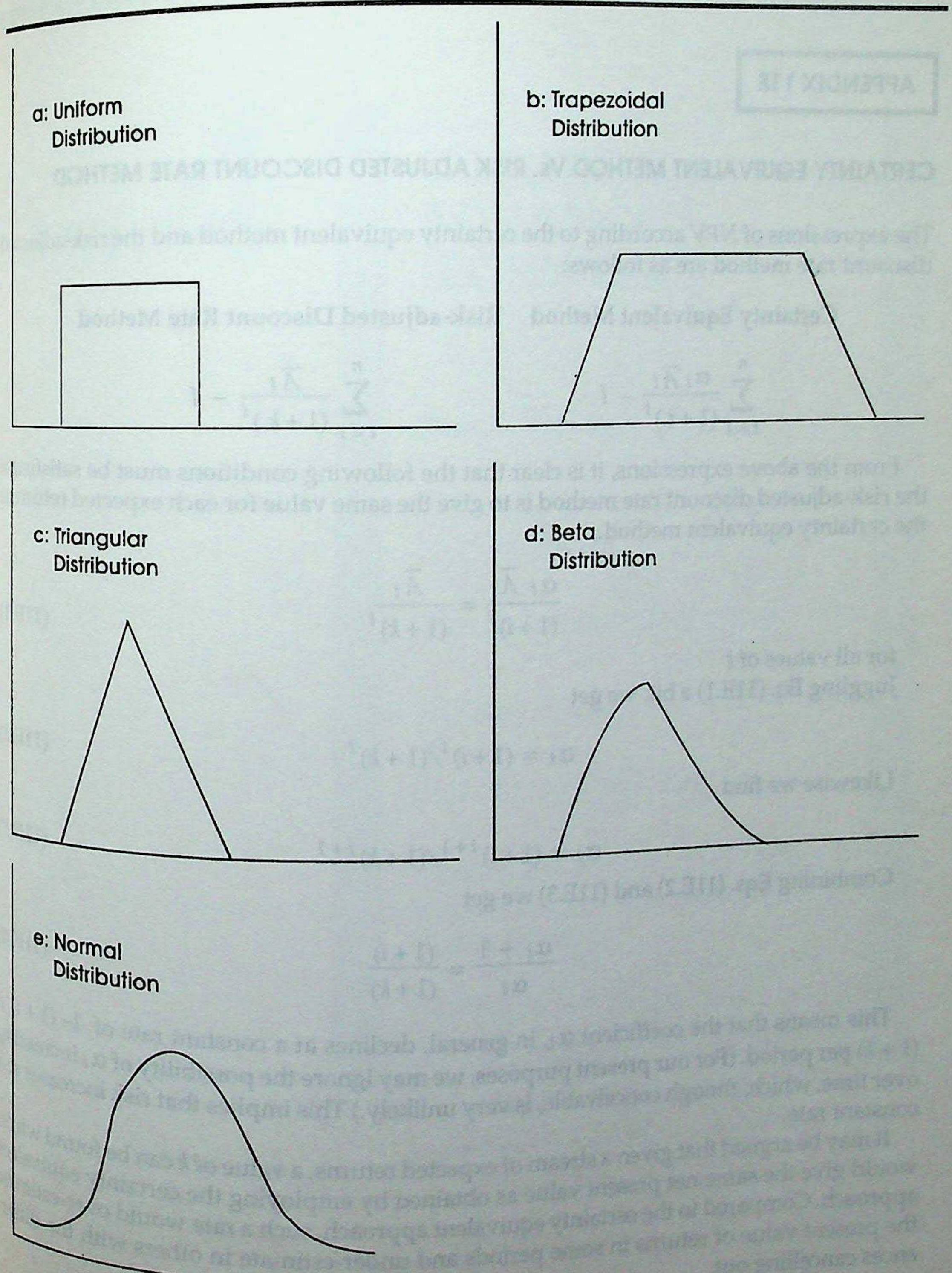
This distribution was used by the World Bank in its project evaluation exercises essentially as a compromise between the uniform distribution, which requires minimal information, and the step rectangular distribution, which requires detailed information. The World Bank, however, did not find the beta distribution very helpful.

Normal Distribution

This is a very important theoretical distribution. However, it is of limited use in risk analysis wherein the variations that are sought to be captured are caused neither by statistical errors nor random disturbances.

EXHIBIT 11D.1

Some Probability Distributions


a: Uniform
Distribution
b: Trapezoidal
Distribution
c: Triangular
Distribution
d: Beta
Distribution
e: Normal
Distribution

APPENDIX 11E

CERTAINTY EQUIVALENT METHOD Vs. RISK ADJUSTED DISCOUNT RATE METHOD

The expressions of *NPV* according to the certainty equivalent method and the risk-adjusted discount rate method are as follows:

Certainty Equivalent Method	**Risk-adjusted Discount Rate Method**
$\sum_{t=1}^{n} \frac{\alpha_t \overline{A}_t}{(1+i)^t} - I$	$\sum_{t=1}^{n} \frac{\overline{A}_t}{(1+k)^t} - I$

From the above expressions, it is clear that the following conditions must be satisfied if the risk-adjusted discount rate method is to give the same value for each expected return as the certainty equivalent method.

$$\frac{\alpha_t \overline{A}_t}{(1+i)^t} = \frac{\overline{A}_t}{(1+k)^t} \tag{11E.1}$$

for all values of t

Juggling Eq. (11E.1) a bit, we get

$$\alpha_t = (1+i)^t/(1+k)^t \tag{11E.2}$$

Likewise we find

$$\alpha_t = (1+i)^{t+1}/(1+k)^{t+1} \tag{11E.3}$$

Combining Eqs. (11E.2) and (11E.3) we get

$$\frac{\alpha_t + 1}{\alpha_t} = \frac{(1+i)}{(1+k)} \tag{11E.4}$$

This means that the coefficient α_t, in general, declines at a constant rate of $1-(1+i)/(1+k)$ per period. (For our present purposes, we may ignore the possibility of α_t increasing over time, which, though conceivable, is very unlikely.) This implies that risk increases at a constant rate.

It may be argued that given a stream of expected returns, a value of k can be found which would give the same net present value as obtained by employing the certainty equivalent approach. Compared to the certainty equivalent approach, such a rate would over-estimate the present value of returns in some periods and under-estimate in others with the differences cancelling out.

However, it should be borne in mind that the net present value, not *k*, is the unknown. Thus, it is difficult to see how *k* can be interpreted as a reasonable standard for discounting purposes unless Eq. (11E.2) is satisfied. Hence, on a conceptual level, the certainty equivalent approach is superior to the risk-adjusted discount rate approach.

PART 4

SELECTION II: ADVANCED TECHNIQUES

Special Decision Situations

Risk Analysis: Firm Risk and Market Risk

Social Cost Benefit Analysis

Multiple Projects and Constraints

Options and Flexibility

Qualitative Factors, Strategic Aspects and Organisational Considerations

12

Special Decision Situations

Our discussion so far assumed that : (i) Every project being considered is independent. This means, among other things, that we don't have a situation where two or more projects are mutually exclusive. (ii) A project is being considered for implementation now or never. (iii) The economic life of a project is fixed. (iv) The investment and financing aspects of a project are independent. (v) The cash flows of a project may be estimated on the basis of current prices.

This chapter discusses decision situations where there are mutually exclusive projects, where a project can be deferred by one or more years, where the economic life of a project is not predetermined and fixed, where the investment and financing side of the project are related, and where inflation is explicitly considered in evaluating the project. It is divided into five sections as follows:

- Choice between mutually exclusive projects of unequal life
- Optimal timing decision
- Determination of economic life
- Interrelationship between investment and financing aspects
- Inflation and capital budgeting

CHOICE BETWEEN MUTUALLY EXCLUSIVE PROJECTS OF UNEQUAL LIFE

Alpha Limited is considering two machines, A and B. Though designed differently, they serve the same function. Machine A, a standard model, costs Rs 75,000 and lasts for 5 years. Its annual operating costs will be Rs 12,000. Machine B, an economy model, costs Rs 50,000 but lasts for only 3 years. Its annual operating costs will be Rs 20,000. (All the figures are expressed in real terms; this means that they represent rupees of constant purchasing power.)

How should Alpha Limited choose between the two machines? Since they serve the same function, the choice between them should be based on a comparison of costs. One way of doing this may be to compare the present value of all the costs associated with the two machines. Assuming a discount rate of 12 per cent, the present value of all the costs associated with the two machines are:

$$\text{Machine A:} \quad 75{,}000 + \frac{12{,}000}{(1.12)} + \frac{12{,}000}{(1.12)^2} + \frac{12{,}000}{(1.12)^3} + \frac{12{,}000}{(1.12)^4} + \frac{12{,}000}{(1.12)^5} = 118{,}260$$

$$\text{Machine B:} \quad 50{,}000 + \frac{15{,}000}{(1.12)} + \frac{15{,}000}{(1.12)^2} + \frac{15{,}000}{(1.12)^3} = 86{,}030$$

The present value of costs associated with machine B is lower than that of machine A. Based on such a comparison, one may argue that machine B is preferable to machine A. Such an argument, however, is flawed because it overlooks the fact that machine B has a shorter life and has to be replaced earlier.

For a proper comparison of the two alternatives, that have different lives, we have to convert the present value of costs into a uniform annual equivalent (*UAE*) figure. The *UAE* is a function of the present value of cost, the life of the asset, and the discount rate. The *UAE* is simply:

$$\frac{PV\ \text{Cost}}{PVIFA_{k,\,n}}$$

The *UAE* of the two machines is calculated below:

$$\text{Machine A:} \quad UAE = \frac{118{,}260}{3.605} = 32{,}804$$

$$\text{Machine B:} \quad UAE = \frac{86{,}030}{2.402} = 35{,}816$$

What does a *UAE* value of Rs 32,804 for machine A mean? It simply means that incurring a capital outlay and operating costs which have a present value of Rs 118,260 for a machine that lasts five years is like incurring an annual cost of Rs 32,804 for five years. Likewise a *UAE* value of Rs 35,816 for machine B implies that incurring a capital outlay and operating costs which have a present value of Rs 86,030 for a machine that lasts three years is like incurring an annual cost of Rs 35,816 for three years.

The choice between machines A and B can be made by comparing their *UAE*. Since the *UAE* of machine A is lower than the *UAE* of machine B, machine A is preferable to machine B.

OPTIMAL TIMING

In real life, an investment is rarely a "now or never" proposition. Typically, it can be undertaken now or at some point of time in future. Given this option, the issue of optimal timing assumes significance.

Under conditions of certainty, the optimal timing may be determined by using the following procedure.

1. Examine alternative dates (t) when the investment can be made.
2. Estimate the net future value as of each alternative date and convert the same to its current value.
3. Choose the timing that has the highest current value.

This procedure may be explained with the help of an example. Futuristic Limited is evaluating different dates for investing in a micro-electronics project. The net future value for various dates is as follows:

Time	Net future value (Rs in million)
0	20
1	28
2	33
3	36
4	38

The discount rate applicable for the project is 12 per cent. Hence the current value for different timing options is as follows:

Time	Current value (Rs in million)
0	$\frac{20}{(1.12)^0} = 20.00$
1	$\frac{28}{(1.12)^1} = 25.00$
2	$\frac{33}{(1.12)^2} = 26.30$
3	$\frac{36}{(1.12)^3} = 22.90$
4	$\frac{38}{(1.12)} = 21.55$

The optimal timing is year 2 as it maximises the current value.

Thus, determining the optimal timing under conditions of certainty is a fairly easy proposition. Under conditions of uncertainty, however, the problem of optimal timing is very complex. If an investment is not undertaken now ($t = 0$) it may become either more or less valuable in future and there may be no way of figuring that out. Perhaps it may be advantageous to exploit a good opportunity today even though it may become more attractive in future. Or it may be worthwhile to wait for the resolution of some uncertainty to minimise the possibility of an investment blunder.

DETERMINATION OF ECONOMIC LIFE

A distinction may be made between the physical life and the economic (or optimal) life of an asset. The physical life of an asset represents the number of years it can be used to produce a certain output by regular maintenance and repair (which, of course, tends to cost more and more as the years roll by). The economic life of an asset refers to the number of years the asset should be used to produce a certain output.

The economic life of an asset is influenced by the behaviour of operating and maintenance costs on the one hand and capital costs on the other. Operating and maintenance costs cover labour, material, and power expenses to operate, maintain, and repair the asset. Capital costs, also referred to as ownership costs, represent the decline in the value of the asset over time—this decline occurs as the asset is used up for producing goods and also as it ages with the passage of time.

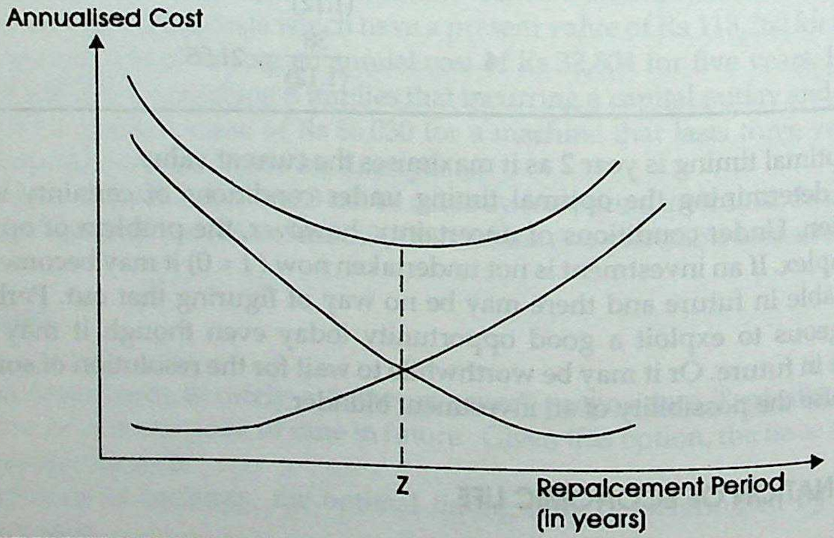
The economic life of an asset is conceptually defined as the period after which the asset should be replaced to minimise the sum of operating and maintenance costs and capital costs expressed on an annual basis. Put differently, it is the replacement cycle that minimises the uniform annual equivalent total cost, $UAE\,(TC)$ of operating and owning the asset. The $UAE\,(TC)$ is simply the sum of the uniform annual equivalent operating and maintenance cost, $UAE\,(OM)$, and the uniform annual equivalent capital cost, $UAE\,(CC)$. That is,

$$UAE\,(TC) = UAE\,(OM) + UAE\,(CC) \tag{12.1}$$

Exhibit 12.1 shows the behaviour of $UAE\,(OM)$, $UAE\,(CC)$, and $UAE\,(TC)$ as the replacement cycle is extended. $UAE\,(OM)$ increases as the replacement period is lengthened because with aging it costs more and more to operate, maintain, and repair the asset to produce a given quantity and quality of output. The $UAE\,(CC)$, however, declines as the replacement cycle is extended. This happens because, as the asset is used for a longer period, the capital cost per year falls.

EXHIBIT 12.1

Costs Over the Life of Machine



Since $UAE(OM)$ rises and $UAE(CC)$ falls with the lengthening of the replacement period, their sum, $UAE\,(TC)$, will be minimised for some replacement period. As shown in Exhibit 12.1, $UAE\,(TC)$ is minimised when the replacement period is 2 years.

The Problem

We have discussed conceptually how the economic life of an asset is defined. Its measurement in practice involves a series of calculations, which may be illustrated with the help of an example. Modern Plastics Limited is considering a machine to produce plastic products. It requires an initial outlay of Rs 0.6 million and will be depreciated at a rate of 33 1/3 per cent per annum as per the written down value method for income tax purposes. The expected operating and maintenance costs and salvage (market) value for the next eight years which represents the maximum physical life of the machine are shown in Exhibit 12.2. The cost of capital appropriate for the machine is 12 per cent and the tax rate for Modern Plastics Limited is 40 per cent. Not sure of what the economic life of the machine is, the firm seeks your help in determining it.

EXHIBIT 12.2

Operating and Maintenance Costs and Salvage Value for the Machine

Rs ('000)

Year	1	2	3	4	5	6	7	8
Operating and maintenance cost	80.00	100.00	130.00	180.00	240.00	300.00	360.00	450.00
Salvage value at time *t*	400.00	252.00	180.00	100.00	80.00	60.00	50.00	40.00

To determine the economic life of the machine, it is useful to separately consider the operating and maintenance cost and the capital cost. When these are adjusted for taxes and translated into *UAE* form, the behaviour of *UAE* (*TC*) with respect to replacement period can be studied and the economic life determined.

Operating and Maintenance Costs

To obtain the *UAE*(*OM*) for various replacement periods, the following calculations may be done:

1. Convert the operating and maintenance costs into post-tax terms.
2. Discount the post-tax operating and maintenance costs to obtain their present values.
3. Cumulate the present values for various replacement periods.
4. Calculate the *UAE*(*OM*) for various replacement periods by applying suitable annuity factors.

Exhibit 12.3 shows the calculation of *UAE*(*OM*) for the various replacement cycles for the machine being considered by Modern Plastics. The first row shows the operating and maintenance costs as taken from Exhibit 12.2; the second row converts the operating and maintenance costs into post-tax terms; the third row gives the present value interest factors, assuming a discount rate of 12 per cent; the fourth row translates the post-tax operating and maintenance costs into their present values; the fifth row cumulates the present values for various replacement periods; the sixth row contains the annuity factors (*PVIFA*s) assuming a discount rate of 12 per cent; finally the seventh row displays the *UAE*(*OM*) for various replacement periods.

EXHIBIT 12.3

Calculation of UAE(OM) for Various Replacement Periods

Rs ('000)

	$t=1$	$t=2$	$t=3$	$t=4$	$t=5$	$t=6$	$t=7$	$t=8$
Operating and maintenance costs	80.00	100.00	130.00	180.00	240.00	300.00	360.00	450.00
Post-tax operating and maintenance costs	48.00	60.00	78.00	108.00	144.00	180.00	216.00	270.00
$PVIF\ (t, k = 12\%)$	0.893	0.797	0.712	0.636	0.567	0.507	0.452	0.404
Present value of post-tax operating and maintenance costs	42.86	47.82	55.54	68.69	81.65	91.26	97.63	109.08
Cumulative present value	42.86	90.68	146.22	214.91	296.56	387.82	485.45	594.53
$PVIFA\ (t, k = 12\%)$	0.893	1.690	2.402	3.037	3.605	4.111	4.564	4.968
$UAE\ (OM)$	48.00	53.66	60.87	70.76	82.26	94.34	106.37	119.67

Capital Costs

To derive the $UAE(CC)$ for various replacement periods, the following components must be taken into account: the initial outlay (IO), depreciation tax shields (DTS), and the net salvage value (SV). The $UAE(CC)$ for a given replacement period is equal to:

$$UAE\ (IO) - [\ UAE\ (DTS) + UAE\ (SV)\ ]$$

The calculations of $UAE\ (IO)$, $UAE\ (DTS)$ and $UAE\ (SV)$ are shown in Exhibits 12.4, 12.5, and 12.6 respectively.

Economic Life

The economic life represents the replacement period which minimises the $UAE(TC)$. The information required to determine the economic life is summarised in Exhibit 12.7. For each replacement period, column 1 shows $UAE(OM)$ drawn from Exhibit 12.3. Columns 2, 3, and 4 show $UAE(IO)$, $UAE(DTS)$, and $UAE(SV)$ drawn from Exhibits 12.4, 12.5, and 12.6 respectively. Column 5 shows $UAE(CC)$, which is $UAE(IO) - [UAE(DTS) + UAE(SV)]$. Finally, column 6 represents $UAE(TC)$, which is simply $UAE\ (OM)$ plus $UAE(CC)$. Looking at the column for $UAE(TC)$ we find that $UAE(TC)$ is minimised when the replacement period is 5 years. So the economic life is 5 years.

INTERRELATIONSHIP BETWEEN INVESTMENT AND FINANCING ASPECTS

The use of weighted average cost of capital is based, *inter alia*, on the assumption that every project is financed by the same proportions of debt and equity as found in the capital structure of the firm. Projects, however, tend to differ in their debt capacity and other features like availability of subsidies, etc. Hence financing and investment decisions are likely to be interrelated. When this is so, we must take into account the financing impact of an investment decision. This may be done either by calculating the adjusted NPV or by using the adjusted discount rate.

EXHIBIT 12.4

Calculation of UAE (IO) for Various Replacement Periods

Rs ('000)

	$t=1$	$t=2$	$t=3$	$t=4$	$t=5$	$t=6$	$t=7$	$t=8$
Investment outlay	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00
PVIFA ($t, k = 12\%$)	0.893	1.690	2.402	3.037	3.605	4.111	4.564	4.968
UAE (IO)	671.89	355.03	249.79	197.56	166.45	145.95	131.46	120.77

EXHIBIT 12.5

Calculation of UAE(DTS) for Various Replacement Periods

Rs ('000)

	$t=1$	$t=2$	$t=3$	$t=4$	$t=5$	$t=6$	$t=7$	$t=8$
Depreciation charge	200.00	133.33	88.89	59.26	39.51	26.34	17.56	11.70
Depreciation tax shield	80.00	53.33	35.55	23.70	15.80	10.53	7.02	4.68
PVIF ($t, k = 12\%$)	0.893	0.797	0.712	0.636	0.567	0.507	0.452	0.404
Present value of depreciation tax shield	71.44	42.50	25.31	15.07	8.96	5.34	3.17	1.89
Cumulative present value	71.44	113.94	139.25	154.32	163.28	168.62	171.79	173.68
PVIFA ($t, k = 12\%$)	0.893	1.690	2.402	3.037	3.605	4.111	4.564	4.968
UAE (DTS)	80.00	67.42	57.97	50.81	45.29	41.02	37.64	34.96

EXHIBIT 12.6

Calculation of UAE(SV)for Various Replacement Periods

Rs ('000)

Period	$t=1$	$t=2$	$t=3$	$t=4$	$t=5$	$t=6$	$t=7$	$t=8$
Salvage value	400.00	252.00	180.00	100.00	80.00	60.00	50.00	40.00
PVIF ($t, k = 12\%$)	0.893	0.797	0.712	0.636	0.567	0.507	0.452	0.404
Present value of salvage value	357.20	200.84	128.16	63.60	45.36	30.42	22.60	16.16
PVIFA($t, k = 12\%$)	0.893	1.690	2.402	3.037	3.605	4.111	4.564	4.968
UAE (SV)	400.00	118.84	53.36	20.94	12.58	7.40	4.95	3.25

Adjusted Net Present Value

The adjusted *NPV* of a project is its *NPV* calculated after making adjustments for the financing impact of the project. The calculation of adjusted *NPV* begins with the 'base-case' *NPV* which is defined as the *NPV* under the assumption that the project is all-equity financed. Once the 'base case' *NPV* is obtained, adjustments are made to it to reflect the impact of the project on financing. Thus

EXHIBIT 12.7

Summary of Information Required to Determine the Economic Life

Replacement period	UAE (OM)	UAE (IO)	UAE (DTS)	UAE (SV)	UAE (CC)	UAE (TC)
1 year	48.00	671.89	88.00	400.00	183.89	231.89
2	53.66	355.03	67.42	118.84	168.77	222.43
3	60.68	249.79	57.97	53.36	138.46	199.14
4	70.76	197.56	50.81	20.94	125.81	196.57
5	82.26	166.44	45.29	12.58	108.57	190.83
6	94.34	145.95	41.02	7.40	97.53	191.87
7	106.37	131.46	37.64	4.95	88.87	195.24
8	119.67	120.77	34.96	3.25	82.56	202.23

$$\text{Adjusted } NPV = \text{Base case } NPV + NPV \text{ of financing decisions associated with the project}$$

Illustration

The adjusted *NPV* calculation may be illustrated with an example. Parimala Company is considering a project requiring Rs 5 million of investment. It is expected to generate a net cash flow of Rs 1 million per year for 8 years. The opportunity cost of capital is 15 per cent —this reflects the return required by equity investors from the project. The cost of issuing equity is 5 per cent. The project enables the firm to raise Rs 2.4 million of debt finance. The debt finance will carry 14 per cent interest and will be repaid in equal annual instalments over the eight year period—the first instalment will be paid at the end of the first year. The tax rate applicable to the firm is 60 per cent.

Given the above information about the project, let us first calculate its base case *NPV*. This is equal to:

$$-500{,}000 + \sum_{t=1}^{8} \frac{1{,}000{,}000}{(1.15)^2} = -\text{Rs } 512{,}700$$

The base-case *NPV* has to be adjusted for two factors: (i) issue cost, and (ii) tax-shield associated with debt.

Out of the total financing requirement of the project Rs 2,600,000 will come from the equity sources and Rs 2,400,000 will come in the form of debt finance. As the net equity finance required by the project is Rs 2,600,000 and issue costs would absorb 5 per cent of the gross proceeds of the issue, the firm will have to issue Rs 2,736,842 (Rs 2,600,000/ 0.95) of equity stock in order to realise a net amount of Rs 2,600,000. The difference of Rs 136,842 is the cost of underwriting, brokerage, printing, and other issue related expenses. The adjusted *NPV* after adjustment for issue cost is:

$$\begin{aligned}\text{Adjusted } NPV &= \text{Base case } NPV - \text{Issue cost}\\ &= -\text{Rs } 512{,}700 - \text{Rs } 136{,}842\\ &= -\text{Rs } 649{,}542\end{aligned}$$

Now we consider the adjustment for the tax shield associated with debt finance. The present value of tax shield associated with Rs 2,400,000 of debt finance is calculated in Exhibit 12.8. From this exhibit we find that the debt finance associated with the project brings a stream of tax shields which has a present value of Rs 604,000. If we make adjustment for this also, we get:

Adjusted *NPV* = Base case *NPV* – Issue cost + Present value of tax shield
= – Rs 512,700 – Rs 136,842 + Rs 604,000
= – Rs 45,542

EXHIBIT 12.8

Calculation of the Present Value of Tax Shield

(Rs in '000)

Year	Debt outstanding at the beginning	Interest	Tax shield	Present value of tax shield
1	2400	336	202	177
2	2100	294	176	135
3	1800	252	151	102
4	1500	210	126	75
5	1200	168	101	52
6	900	126	76	34
7	600	84	50	20
8	300	42	25	9
			Total	604

Since the adjusted *NPV* after both the adjustments is negative, we conclude the project is not worthwhile.

Adjusted Cost of Capital

The adjusted *NPV*, though conceptually sound, is not very popular because (i) it requires some financial sophistication to assess the financing side effects, and (ii) it involves a series of adjustments and a cumbersome procedure. Hence, firms may employ a simpler procedure which calls for adjusting the cost of capital so that it reflects the opportunity cost of capital as well as the financing effects of the project.

What is adjusted cost of capital? The adjusted cost of capital for a project may be defined as the minimum rate of return the project must earn so that it is just acceptable. The calculation of adjusted cost of capital may be illustrated with two examples.

Example 1: Captive Power Plant Project

A firm is considering a project for setting up a captive power plant for which the following financial details are available.

Investment required	Rs 5 million
Annual post-tax savings	Rs 0.5 million
Life of the project	Perpetual
Debt capacity of the project	Rs 2.5 million
Interest rate on debt	10 per cent
Nature of debt	Perpetual
Tax rate of the firm	60 per cent
Opportunity cost of capital	12 per cent

Given the above details, we may calculate the following:

$$\begin{aligned}
\text{Base case } NPV &= -5{,}000{,}000 + \frac{500{,}000}{0.12} \\
&= -\text{Rs } 833{,}000 \\
\text{Annual tax shield} &= 2{,}500{,}000 \times 0.10 \times 0.60 \\
&= \text{Rs } 150{,}000 \\
\text{Present value of tax shield} &= \frac{150{,}000}{0.10} = \text{Rs } 1{,}500{,}000 \\
\text{Adjusted } NPV &= \text{Base case } NPV + \text{Present value of tax shield} \\
&= -833{,}000 + 1{,}500{,}000 \\
&= \text{Rs } 667{,}000
\end{aligned}$$

It is clear that the power plant is not acceptable as an all-equity financed project but becomes acceptable when its contribution to debt capacity is recognised. Given the present value of tax shield of Rs 1,500,000 the project would be acceptable as long as the base case *NPV* is equal to or greater than – Rs 1,500,000. What does it mean in terms of the minimum acceptable income from the project? To figure this out, we set the base case *NPV* at – Rs 1,500,000 and determine the project's annual income corresponding to it:

$$-1{,}500{,}000 = -5{,}000{,}000 + \frac{\text{Annual income}}{0.12}$$

$$\begin{aligned}
\frac{\text{Annual income}}{0.12} &= 3{,}500{,}000 \\
\text{Annual income} &= 3{,}500{,}000\,(0.12) \\
&= \text{Rs } 420{,}000
\end{aligned}$$

The internal rate of return corresponding to this minimum acceptable income is: 420,000/5,000,000 = 8.4 per cent.[1] This represents the adjusted cost of capital.

Example 2: Real Estate Project

A real estate company is considering the acquisition of a piece of land which it plans to resell after a year. The following financial information is available.

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[1] It may be noted that as the project generates a constant perpetual cash flow, its *IRR* is equal to annual cash flow divided by initial investment.

Investment	Rs 1 million
Cash inflow expected after a year	Rs 1.15 million
Debt capacity	Rs 0.5 million
Interest rate on debt	17.65 per cent
Tax rate of the firm	60 per cent
Opportunity cost of capital	20 per cent

On the basis of the above information, the following may be calculated.

$$\text{Base case } NPV = -1{,}000{,}000 + \frac{1{,}150{,}000}{1.20}$$

$$= -41{,}667$$

$$\text{Tax shield} = 500{,}000 \times (0.1765) \times (0.60)$$

$$= \text{Rs } 52{,}950$$

$$\text{Present value of tax shield} = \text{Rs } \frac{52{,}950}{1.1765}$$

$$= \text{Rs } 45{,}000$$

$$\text{Adjusted } NPV = \text{Base case } NPV + \text{ Present value of tax shield}$$

$$= -41{,}667 + 45{,}000$$

$$= \text{Rs } 3{,}333$$

This project, too, is not acceptable as an all-equity financed project but becomes acceptable when its tax shield is considered. The project would be acceptable even if the base case *NPV* were – Rs 45,000. Setting the base case *NPV* at this level, we may solve for the cash flow:

$$-45{,}000 = -1{,}000{,}000 + \frac{\text{Cash flow}}{1.20}$$

$$\text{Cash flow} = 955{,}000\ (1.20) = \text{Rs } 1{,}146{,}000$$

Thus the minimum acceptable cash flow from the project a year hence is Rs 1,146,000. This means that the minimum acceptable *IRR* from the project is :

$$\frac{1{,}146{,}000}{1{,}000{,}000} - 1 = 0.146 = 14.6 \text{ per cent}$$

This then is the adjusted cost of capital, r^*, for the project.

Shorthand Formulae

The above examples illustrate the concept of adjusted cost of capital. The procedure used in these examples to calculate the adjusted cost of capital, however, is somewhat cumbersome. Moreover, there is an element of redundancy, too, because once the adjusted *NPV* is known, there is no need to know the adjusted cost of capital as far as decision making is concerned. Is there some simple method of calculating the adjusted cost of capital, r^*? Two useful shorthand formulae have been provided, one by Modigliani and Miller and the other by Miles and Ezzell.

Modigliani and Miller formula: $r^* = r\,(1 - T L)$ (12.2)

Miles and Ezzell formula: $$r^* = r - L\,r_D\,T\,\frac{1+r}{1+r_D} \tag{12.3}$$

where r^* = adjusted cost of capital

r = opportunity cost of capital assuming 100 per cent equity financing

T = tax rate applicable to the firm

L = marginal contribution of the project to the firm's debt capacity

r_D = cost of debt capital

Let us apply these formulae to the two projects discussed earlier, namely, the captive power plant project and the real estate project.

Captive Power Project

$$r = 0.12,\ r_D = 0.10,\ T = 0.60,\ L = 0.5$$

Modigliani and Miller formula value:

$$r^* = r\,(1 - T\,L)$$

$$r^* = 0.12\,(1 - 0.6 \times 0.5) = 0.084 \text{ or } 8.4 \text{ per cent}$$

Miles and Ezzell formula value:

$$r^* = r - L\,r_D T\,\frac{1+r}{1+r_D}$$

$$r^* = 0.12 - 0.5 \times 0.10 \times 0.6\,\frac{1.12}{1.10} = 0.089 \text{ or } 8.9 \text{ per cent}$$

Real Estate Project

$$r = 0.20,\ r_D = 0.1765,\ T = 0.60,\ L = 0.5$$

Modigliani and Miller formula value:

$$r^* = r\,(1 - TL)$$

$$r^* = 0.20\ (1 - 0.6 \times 0.5) = 0.14 \text{ or } 14 \text{ per cent}$$

Miles and Ezzell formula value:

$$r^* = r - L\,r_D\,T\,\frac{1+r}{1+r_D}$$

$$= 0.20 - 0.5 \times 0.1765 \times 0.60\ \frac{1.20}{1.1765}$$

$$= 0.146 = 14.6 \text{ per cent}$$

The Modigliani and Miller formula is valid when a project generates constant perpetual cash flow and supports permanent debt (these conditions were satisfied by the power project). The Miller and Ezzell formula requires that the firm maintain a constant debt proportion, but it does not presuppose any particular cash flow pattern or project life.

INFLATION AND CAPITAL BUDGETING

Inflation has been a persistent feature of the Indian economy. Hence, it should be properly considered in capital investment appraisal. In practice, however, adjustment for inflation is rarely, if ever, made. The use of current price structure is deemed satisfactory and the reasoning offered runs as follows:

> "Inflation is expected to raise the revenues and cost of the project in a similar fashion. Hence, net revenues after adjustment for inflation would be equal to net revenues in current terms."

The above argument, however, overlooks the following considerations which cause distortion:

1. The depreciation charge is based on historical costs and hence the tax benefits arising from it does not keep pace with inflation.
2. The cost of capital used for investment appraisal contains a premium for anticipated inflation.

Bias Due to Depreciation Charge Based on Historical Cost

The annual after-tax cash inflow of a project is equal to:

$$(R - C - D)\ (1 - T) + D = (R - C)(1 - T) + DT \tag{12.4}$$

where R = revenues from the project

C = costs (other than depreciation) relating to the project

D = depreciation charges

T = tax rate

In Eq. (12.4) the first component on the right-hand side, $(R - C)(1 - T)$, may be expected to move in line with inflation, if inflation influences revenues and costs similarly. The second component, DT, however, is not influenced by inflation because depreciation charges are based on historical costs. Hence, the effect of inflation is to reduce the real rate of return.

To illustrate, let us look at a project which has the following characteristics:

Initial outlay	Rs 80,000
Useful life	4 years
Salvage value	0
Annual revenues	Rs 60,000
Annual costs, other than depreciation	Rs 20,000
Tax rate	50 per cent
Depreciation method	Straight line method

Assuming that there is no inflation the following operational cash inflows are expected.

Year	**1**	**2**	**3**	**4**
	Rs	Rs	Rs	Rs
Revenues	60,000	60,000	60,000	60,000
Costs, other than depreciation	20,000	20,000	20,000	20,000
Depreciation	20,000	20,000	20,000	20,000
Taxable profit	20,000	20,000	20,000	20,000
Tax	10,000	10,000	10,000	10,000
Profit after tax	10,000	10,000	10,000	10,000
Net cash inflow	30,000	30,000	30,000	30,000

Now, consider the case where the annual inflation rate is 10 per cent and this applies to both the revenues and costs of the project. The net cash flows in this case would be as follows:

Year	**1**	**2**	**3**	**4**
	Rs	Rs	Rs	Rs
Revenues	66,000	72,600	79,860	87,846
Costs, other than depreciation	22,000	24,200	26,620	29,282
Depreciation	20,000	20,000	20,000	20,000
Taxable profit	24,000	28,400	33,240	38,564
Tax	12,000	14,200	16,620	19,282
Profit after tax	12,000	14,200	16,620	19,282
Net cash inflow	32,000	34,200	36,620	39,282

The real net cash flow stream after deflating for the inflation rate of 10 per cent is:

Year	**1**	**2**	**3**	**4**
Real net cash flow	Rs 29,091	Rs 28,264	Rs 27,513	Rs 26,830

The real net cash flows shown above are less than the net cash flows when it is assumed that there is no inflation. Thus, when revenues and costs of a project rise in response to inflation, the cash flow stream calculated by abstracting away the effect of inflation is an over-estimate of the real net cash flow stream.

Bias Due to Ignoring the Inflation Factor in Project Cash Flows

The cost of capital of a project (the required rate of return) contains a premium for anticipated inflation. In the wake of inflation, investors would require the nominal rate of interest to be equal to the real required rate of return plus the rate of inflation.

$$R_N = R_R + P \tag{12.5}$$

where
R_N = required rate of return in nominal terms
R_R = required rate of return in real terms
P = anticipated inflation rate.

Now, if the cost of capital (the required rate of return) contains a premium for anticipated inflation, the factor of inflation must be reflected in the projected cash flows as well, to ensure that there is consistency between the two. If, as is commonly done, the project cash flows do not reflect the factor of inflation, the appraisal tends to be biased. To illustrate the nature of this bias, let us look at a project with the following characteristics:

Initial outlay	Rs 40,000
Annual revenues	Rs 30,000 (in current rupees)
Annual costs excluding depreciation	Rs 10,000 (in current rupees)
Useful life	4 years
Salvage value	0
Tax rate	50 per cent
Cost of capital	12 per cent (including an inflation premium of 5 per cent).

The net cash inflows of this project, ignoring the effect of inflation, are shown below:

Year	1	2	3	4
	Rs	Rs	Rs	Rs
Revenues	30,000	30,000	30,000	30,000
Costs, other than depreciation	10,000	10,000	10,000	10,000
Depreciation	10,000	10,000	10,000	10,000
Taxable profit	10,000	10,000	10,000	10,000
Tax	5,000	5,000	5,000	5,000
Profit after tax	5,000	5,000	5,000	5,000
Net cash inflow	15,000	15,000	15,000	15,000

The net present value of this project using an inflation-adjusted discount rate of 12 per cent is:

$$\frac{15,000}{(1.12)} + \frac{15,000}{(1.12)^2} + \frac{15,000}{(1.12)^3} + \frac{15,000}{(1.12)^4} - 40,000 = \text{Rs } 5,555$$

The net cash inflows of the project, if the revenues and costs are expected to grow at the rate of 10 per cent per annum in the wake of inflation, are as follows:

Year	1	2	3	4
	Rs	Rs	Rs	Rs
Revenues	33,000	36,300	39,930	43,923
Costs, other than depreciation	11,000	12,100	13,310	14,641
Depreciation	10,000	10,000	10,000	10,000
Taxable profit	12,000	14,200	16,620	19,282
Tax	6,000	7,100	8,310	9,641
Profit after tax	6,000	7,100	8,310	9,641
Net cash inflow	16,000	17,100	18,310	19,641

The present value of the project, applying the inflation-adjusted discount rate (12 per cent) to the nominal cash flow stream is:

$$\frac{16{,}000}{(1.12)} + \frac{17{,}100}{(1.12)^2} + \frac{18{,}310}{(1.12)^3} + \frac{19{,}641}{(1.12)^4} - 40{,}000 = 13{,}446$$

Proper Adjustment for Inflation

The above illustration demonstrates the need for considering the effect of inflation on projected cash flows when the discount factor contains inflation premium. Equation (12.6) shows the calculation of *NPV* based on an explicit consideration of inflation in revenues and costs.

$$NPV = \sum_{t=1}^{n} \frac{\left[R_t \overset{t}{\underset{\tau=1}{\pi}} (1 + i'_\tau) - C_t \overset{t}{\underset{\tau=1}{\pi}} (1 + i_\tau) \right] (1 - T) + D_t T}{(1 + k)^t} - I_0 \tag{12.6}$$

where
NPV = net present value
R_t = revenues for year t based on the assumption of no inflation
i'_τ = annual inflation rate in revenues for year τ
C_t = costs for year t based on the assumption of no inflation
i_τ = annual inflation rate of costs for year τ
D_t = Depreciation charge for year t
I_0 = initial outlay
k = cost of capital, reflecting inflation premium

Illustration

Stancil Limited is considering an investment project requiring an outlay of Rs 800,000. The project would have a useful life of four years after which its salvage value would be nil. The depreciation charge would be Rs 200,000 per year. The expected revenues and costs (excluding depreciation) ignoring inflation would be as follows:

Year	Revenues	Costs
	Rs	Rs
1	600,000	300,000
2	700,000	400,000
3	800,000	400,000
4	800,000	400,000

The tax rate for the company will be 60 per cent and the cost of capital is 12 per cent. Calculate the net present value of the project under the assumption that the inflation rates for revenues and costs would be as follows:

Year	Revenues (%)	Costs (%)
1	10	12
2	9	10
3	8	9
4	7	8

Applying Eq. (12.6), the net present value may be obtained as follows:

$$NPV = \frac{[\,600{,}000\ (1.10) - 300{,}000\ (1.12)\,]\ (1-0.6) + 200{,}000 \times 0.6}{(1.12)}$$

$$+ \frac{[\,700{,}000\ (1.10)\ (1.09) - 400{,}000\ (1.12)\ (1.10)\,]\ (1-0.6) + 200{,}000 \times 0.6}{(1.12)^2}$$

$$+ \frac{[\,800{,}000\ (1.10)\ (1.09)\ (1.08) - 400{,}000\ (1.12)\ (1.10)\ (1.09)]\ (1-0.6) + 200{,}000 \times 0.6}{(1.12)^3}$$

$$+ \frac{[\,800{,}000\ (1.10)\ (1.09)\ (1.08)\ (1.07) - 400{,}000\ (1.12)\ (1.10)\ (1.09)\ (1.08)\,]\ (1-0.6) + 200{,}000 \times 0.6}{(1.12)^4}$$

$$- 800{,}000$$

$$= \text{Rs } 67{,}100$$

SUMMARY

- For a proper comparison of two mutually exclusive alternatives, that have different lives, we have to convert the present value of costs into a uniform annual equivalent (*UAE*) figure.

  The *UAE* is simply:

  $$PV\ \text{(Cost)}/PVIFA_{k,\,n}$$

- In real life, an investment can typically be undertaken now or at some point of time in future. The timing that has the highest current value represents the optimal timing.
- The economic life of an asset is conceptually defined as the period after which the asset should be replaced to minimise the sum of operating and maintenance costs and capital costs expressed on an annual basis.
- The adjusted *NPV* of a project is its *NPV* calculated after making adjustment for the financing impact of the project.
- The adjusted cost of capital for a project may be defined as the minimum rate of return the project must earn so that it is just acceptable, after taking into account its financing impacts.
- The adjustment for inflation in project appraisal should be made properly.

QUESTIONS

1. Explain how you would compare mutually exclusive projects of unequal life.
2. Discuss the procedure for determining optimal timing under conditions of certainty.
3. Distinguish between the physical life and the economic (or optimal) life of an asset. How would you determine the latter?
4. What is adjusted *NPV*?
5. What is adjusted cost of capital?
6. Discuss the bias when the depreciation charge is based on historical cost.
7. Discuss the bias due to ignoring the inflation factor in project cash flows.

PROBLEMS

1. Plastic emulsion painting for a building costs Rs 300,000 and has a life of 7 years. Distemper painting costs Rs 180,000 and has a life of 3 years. How does the *UAE* of plastic emulsion painting compare with that of distemper painting?
2. The initial outlay on an internal transportation system would be Rs 1,500,000. The operating costs are expected to be as follows:

Year	Operating Costs
	Rs
1	300,000
2	360,000
3	400,000
4	450,000
5	500,000

The estimated salvage value at the end of five years is Rs 300,000. What is the *UAE* if the cost of capital is 13 per cent?

3. The standard overhaul of an equipment costs Rs 0.5 million and is required every 6 years. A less costly overhaul can be done for Rs 0.2 million and is required every 2 years. Which one would you recommend if the cost of capital is 14 per cent? Why?
4. Shimla Municipality is considering two different snowplows. The Gunning plow has an economic life of 12 years, whereas the Coulter plow has an economic life of 9 years. The Gunning plow costs Rs 2.5 million and is expected to have a salvage value of Rs 0.8 million at the end of 12 years. The Coulter plow costs Rs 1.5 million and is expected to have a salvage value of Rs 0.5 million after 9 years. The operating and maintenance costs for the Gunning plow are expected to be Rs 0.25 million per year and the same costs for the Coulter plow are expected to be Rs 0.32 million per year. The plows have identical capacity. Whichever plow is chosen, Shimla Municipality would continue to replace it with essentially the same machine indefinitely. If the discount rate is 12 per cent, which plow should be selected? Ignore taxes.
5. Udyog Limited is evaluating different dates for investing in a drug project. The net future value for various dates is as follows:

Time	Net future value
	(Rs in million)
0	10
1	15
2	19
3	23
4	26

The discount rate applicable to the project is 12 per cent. Determine the optimal timing of the project.

6. Zenith Company sews garments for fabric stores. The firm is evaluating a new sewing machine costing Rs 80,000. The machine has a physical life of five years. The depreciation rate applicable to it is 25 per cent as per the written down value method. The estimated operating and maintenance costs and salvage values are as follows:

Year	Operating and maintenance costs	Salvage value
	Rs	Rs
1	20,000	60,000
2	25,000	45,000
3	35,000	32,000
4	50,000	22,000
5	70,000	15,000

Zenith's cost of capital is 12 per cent and its tax rate is 40 per cent. What is the economic life of the sewing machine which minimises the uniform annual equivalent cash flow of buying and operating the machine?

7. Sushant Well Drillers is evaluating a new well-drilling machine costing Rs 4 million. Estimates of operating and maintenance costs and salvage values are as follows:

Year	Operating and Maintenance Costs	Salvage value
	(Rs in million)	(Rs in million)
1	0.8	2.8
2	1.0	2.0
3	1.3	1.4
4	1.9	1.0
5	2.8	0.8

Sushant has a cost of capital of 12 per cent and a tax rate of 30 per cent. For tax purposes, Sushant is allowed to depreciate the machine at a rate of 25 per cent as per the written down value method.

Determine the economic life for the well-drilling machine that minimises the uniform annual equivalent cash flow of buying and operating the machine.

8. The contribution of a project which involves an outlay of 100 to the firm's debt capacity is 60. The project's opportunity cost of capital is 16 per cent and the tax rate for the firm is 50 per cent. The borrowing rate is 15 per cent.
   (a) What is the adjusted cost of capital as per Modigliani and Miller formula?
   (b) What is the adjusted cost of capital as per Miles and Ezzell formula?
9. Nimesh Electricals Limited is evaluating a capital project requiring an outlay of Rs 12 million. It is expected to generate a net cash inflow of Rs 3 million for 6 years. The opportunity cost of capital is 20 per cent. Nimesh Electricals can raise a term loan of Rs 8 million for the project. It will carry an interest rate of 18 per cent and will be repayable in 8 equal annual instalments, the first instalment falling due at the end of the second year.

   The balance amount required for the project can be raised by issuing external equity. The issue cost is expected to be 12 per cent. The tax rate for the company is 30 per cent.
   (a) What is the base case *NPV*?
   (b) What is the adjusted *NPV* if the adjustment is made only for the issue cost of external equity?
   (c) What is the present value of the tax shield on debt finance?
10. Nikhil Electronics Limited is evaluating a capital project requiring an outlay of Rs 8 million. It is expected to generate a net cash inflow of Rs 2 million for 6 years. The opportunity cost of capital is 18 per cent. Nikhil Electronics Limited can raise a term loan of Rs 5 million for the project. The term loan will carry an interest rate of 15 per cent and would be repayable in 5 equal annual instalments, the first instalment falling due at the end of the second year. The balance amount required for the project can be raised by issuing external equity. The issue cost is expected to be 10 per cent. The tax rate for the company is 40 per cent.
    (a) What is the base case *NPV*?
    (b) What is the adjusted *NPV* if the adjustment is made only for the issue cost of external equity?
    (c) What is the present value of tax shield on debt finance?
11. The contribution of a project which involves an outlay of 100 to a firm's debt capacity is 50. The project's opportunity cost of capital is 19 per cent and the tax rate for the firm is 50 per cent. The borrowing rate is 16 per cent.
    (a) What is the adjusted cost of capital as per the Modigliani and Miller formula?
    (b) What is the adjusted cost of capital as per Miles and Ezzell formula?
12. PNT Company is considering an investment project requiring an outlay of Rs 1,500,000. The project would have a useful life of 5 years after which its salvage value would be nil. Assume that the depreciation charge would be Rs 300,000 per year. The expected revenues and costs (excluding depreciation) ignoring inflation would be as follows:

Year	Revenues	Costs
	Rs	Rs
1	1,200,000	700,000
2	1,300,000	750,000
3	1,400,000	800,000
4	1,400,000	800,000
5	1,200,000	700,000

The tax rate for the company is 60 per cent and the cost of capital is 10 per cent. Calculate the net present value of the project under the assumption that the inflation rates for revenues and costs would be as follows:

Year	Revenues	Costs
1	8%	8%
2	6%	7%
3	6%	8%
4	5%	6%
5	5%	6%

13

Risk Analysis: Firm Risk and Market Risk

In Chapter 11 we looked at the risk of a project in isolation. The questions we tried to answer were: How should the risk of a project, viewed independently, be measured? Given the risk and return characteristics of a project, should it be accepted or rejected?

While looking at a project in isolation may appear convenient and pragmatic, many consider it as a very narrow approach to project evaluation. The critics of the 'project risk' approach fall into two groups. The first group argues that the risk of a project must be judged in the context of the total risk of the firm. This means that the question to be asked is: What is the incremental contribution of a project to the risk exposure of the firm as a whole? To answer this question, portfolio theory is employed. The second group takes an even broader view of risk and argues that the risk of a project must be judged in the context of the aggregate market portfolio of all assets. The analytical model employed by the votaries of this approach is the capital asset pricing model.

This chapter discusses risk analysis from the firm point of view as well as the market point of view. It is organised into five sections as follows:

- Portfolio theory
- Portfolio theory and capital budgeting
- Capital asset pricing model
- Estimation of key factors
- Capital asset pricing model and capital budgeting

PORTFOLIO THEORY

A portfolio is a combination of assets. Portfolio theory shows how an investor can reach his optimal portfolio position. Originally proposed by Harry Markowitz, portfolio theory is based on the assumption that the utility of an investor is a function of two factors: mean (or expected) return and variance (or its square root, the standard deviation) of return. Hence it is referred to as the mean-variance portfolio theory or the two parameter portfolio theory. *Ceteris paribus*, the investor is assumed to (i) prefer a higher mean return to a lower one, and (ii) prefer a lower variance of return to a higher one.

Portfolio Return

The expected return on a portfolio is simply the weighted arithmetic average of the expected returns on the assets constituting the portfolio. For example, when a portfolio consists of two securities, its expected return is:

$$\overline{R}_p = x_1 \overline{R}_1 + (1 - x_1)\overline{R}_2 \tag{13.1}$$

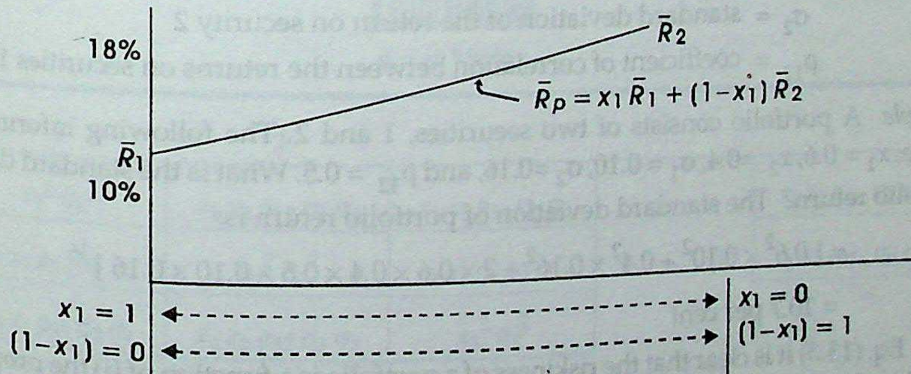
where $\overline{R}_p$ = expected return on a portfolio
x_1 = proportion of portfolio invested in security 1
$\overline{R}_1$ = expected return on security 1
$(1 - x_1)$ = proportion of portfolio invested in security 2[1]
$\overline{R}_2$ = expected return on security 2.

To illustrate, consider a portfolio consisting of two securities, *A* and *B*. The expected returns on these two securities are 10 per cent and 18 per cent respectively. The expected return on the portfolio, when the proportions invested in *A* and *B* are 0.4 and 0.6, is simply: $0.4 \times 10\% + 0.6 \times 18 = 14.8\%$.

The expected portfolio return, a linear function of the expected returns of the constituent securities, is shown graphically in Exhibit 13.1.

EXHIBIT 13.1

Expected Portfolio Return



In general, when a portfolio consists of *n* securities, the expected rate of return on the portfolio is:

$$\overline{R}_p = \sum x_i \overline{R}_i \tag{13.2}$$

where $\overline{R}_p$ = expected return on portfolio
x_i = proportion of portfolio invested in security *i*
$\overline{R}_i$ = expected return on security *i*

---

[1] Since the portfolio in this case consists of only two securities, the proportion invested in security 2 is simply one minus the proportion invested in security 1.

To illustrate, consider a portfolio consisting of five securities with the following expected returns: $\overline{R}_1 = 10$ per cent, $\overline{R}_2 = 12$ per cent, $\overline{R}_3 = 15$ per cent, $\overline{R}_4 = 18$ per cent, and $\overline{R}_5 = 20$ per cent. The portfolio proportions invested in these securities are: $x_1 = 0.1$, $x_2 = 0.2$, $x_3 = 0.3$, $x_4 = 0.2$, and $x_5 = 0.2$. The expected portfolio return is:

$$\begin{aligned}\overline{R}_p &= x_1 \overline{R}_1 + x_2 \overline{R}_2 + x_3 \overline{R}_3 + x_4 \overline{R}_4 + x_5 \overline{R}_5 \\ &= 0.1 \times 10 + 0.2 \times 12 + 0.3 \times 15 + 0.2 \times 18 + 0.2 \times 20 \\ &= 15.5 \text{ per cent}\end{aligned}$$

Portfolio Risk: The 2-Security Case

The risk of a portfolio is measured by the standard deviation of the portfolio rate of return. The risk of a two-asset portfolio, for example, is equal to:

$$\sigma_p^2 = x_1^2 \sigma_1^2 + x_2^2 \sigma_2^2 + 2\, x_1 x_2\, \rho_{12}\, \sigma_1 \sigma_2 \tag{13.3}$$

$$\sigma_p = \left[x_1^2 \sigma_1^2 + x_2^2 \sigma_2^2 + 2\, x_1 x_2\, \rho_{12}\, \sigma_1 \sigma_2 \right]^{1/2} \tag{13.3a}$$

where σ_p = standard deviation of the portfolio return
x_1 = proportion of portfolio invested in security 1
σ_1 = standard deviation of the return on security 1
x_2 = proportion of portfolio invested in security 2
σ_2 = standard deviation of the return on security 2
ρ_{12} = coefficient of correlation between the returns on securities 1 and 2.

Example A portfolio consists of two securities, 1 and 2. The following information is available: $x_1 = 0.6$, $x_2 = 0.4$, $\sigma_1 = 0.10$, $\sigma_2 = 0.16$, and $\rho_{12} = 0.5$. What is the standard deviation of portfolio return? The standard deviation of portfolio return is:

$$\begin{aligned}&= [\, 0.6^2 \times 0.10^2 + 0.4^2 \times 0.16^2 + 2 \times 0.6 \times 0.4 \times 0.5 \times 0.10 \times 0.16 \,]^{1/2} \\ &= 10.7 \text{ per cent}\end{aligned}$$

From Eq. (13.3) it is clear that the riskiness of a portfolio is a function of (i) the proportions invested in the components, (ii) the riskiness of the components, and (iii) the correlation of returns on the component securities.

σ_p^2 may be obtained as the sum of the elements in the following 2×2 matrix:

$$\begin{array}{c|c|c|} & 1 & 2 \\ \hline 1 & x_1^2 \sigma_1^2 & x_1 x_2 \rho_{21} \sigma_1 \sigma_2 \\ \hline 2 & x_2 x_1 \rho_{21} \sigma_2 \sigma_1 & x_2^2 \sigma_2^2 \\ \hline \end{array}$$

The entries in the boxes lying on the diagonal from the top left to the bottom right depend on the variances of returns on securities included in the portfolio. The entries in the other boxes depend on the covariances of returns on securities included in the portfolio. (The covariance, σ_{12}, is equal to the correlation coefficient, ρ_{12}, multiplied by the two standard deviations σ_1 and σ_2.)

Portfolio Risk: The n-Security Case

The variance and standard deviation of an *n*-security portfolio are:

$$\sigma_p^{\ 2} = \sum\sum x_i \, x_j \, \rho_{ij} \, \sigma_i \, \sigma_j \tag{13.4}$$

$$\sigma_p = \left[\sum\sum x_i \, x_j \, \rho_{ij} \, \sigma_i \, \sigma_j \right]^{1/2} \tag{13.4a}$$

where σ_p = standard deviation of portfolio return
x_i = proportion of portfolio invested in security *i*
x_j = proportion of portfolio invested in security *j*
ρ_{ij} = coefficient of correlation between the returns of securities *i* and *j*
σ_i = standard deviation of return on security *i*
σ_j = standard deviation of return on security *j*.

The relationship embodied in Eq. (13.4) is not as complicated as it appears. It is the sum of n^2 terms found in the $n \times n$ matrix shown in Exhibit 13.2.

EXHIBIT 13.2

***n × n* Matrix**

	1	2	3	…	n
1	$x_1{}^2 \sigma_1{}^2$	$x_1 x_2 \rho_{12} \sigma_1 \sigma_2$	$x_1 x_3 \rho_{13} \sigma_1 \sigma_3$	…	$x_1 x_2 \rho_{1n} \sigma_1 \sigma_n$
2	$x_2 x_1 \rho_{21} \sigma_2 \sigma_1$	$x_2{}^2 \sigma_2{}^2$	$x_2 x_3 \rho_{23} \sigma_2 \sigma_3$	…	$x_2 x_n \rho_{2n} \sigma_2 \sigma_n$
3	$x_3 x_1 \rho_{31} \sigma_3 \sigma_1$	$x_3 x_2 \rho_{32} \sigma_3 \sigma_2$	$x_3{}^2 \sigma_3{}^2$	…	
⋮	⋮				⋮
n	$x_n x_1 \rho_{n1} \sigma_n \sigma_1$				$x_n{}^2 \sigma_n{}^2$

An operational procedure for calculating the standard deviation of portfolio return is illustrated with reference to a 4-securities portfolio in Exhibit 13.3. The proportions of these securities are: $x_1 = 0.2$, $x_2 = 0.3$, $x_3 = 0.4$, and $x_4 = 0.1$; the standard deviations of returns on these securities are (in percentages): $\sigma_1 = 4$, $\sigma_2 = 8$, $\sigma_3 = 20$, and $\sigma_4 = 10$; the correlation coefficients among security returns are: $\rho_{12} = 0.3$, $\rho_{13} = 0.5$, $\rho_{14} = 0.2$, $\rho_{23} = 0.6$, $\rho_{24} = 0.8$, $\rho_{34} = 0.4$.

EXHIBIT 13.3

Standard Deviation of the Return on a Portfolio Containing Four Securities

For calculating the standard deviation of the return on the portfolio, data on standard deviations and correlation coefficients may be arranged as follows:

	σ_1	σ_2	σ_3	σ_4		4	8	20	10
σ_1	$\rho_{1,1}$	$\rho_{1,2}$	$\rho_{1,3}$	$\rho_{1,4}$	4	1	0.3	0.5	0.2
σ_2	$\rho_{2,1}$	$\rho_{2,2}$	$\rho_{2,3}$	$\rho_{2,4}$	8	0.3	1	0.6	0.8
σ_3	$\rho_{3,1}$	$\rho_{3,2}$	$\rho_{3,3}$	$\rho_{3,4}$	20	0.5	0.6	1	0.4
σ_4	$\rho_{4,1}$	$\rho_{4,2}$	$\rho_{4,3}$	$\rho_{4,4}$	10	0.2	0.8	0.4	1

The proportions and covariances may be shown as follows. Each entry in the covariance table is the product of (i) the correlation coefficient in the corresponding position in the preceding table, (ii) the standard deviation of its row, and (iii) the standard deviation of its column.

	x_1	x_2	x_3	x_4		0.2	0.3	0.4	0.1
x_1	$c_{1,1}$	$c_{1,2}$	$c_{1,3}$	$c_{1,4}$	0.2	16	9.6	40	8
x_2	$c_{2,1}$	$c_{2,2}$	$c_{2,3}$	$c_{2,4}$	0.3	9.6	64	96	64
x_3	$c_{3,1}$	$c_{3,2}$	$c_{3,3}$	$c_{3,4}$	0.4	40	96	400	80
x_4	$c_{4,1}$	$c_{4,2}$	$c_{4,3}$	$c_{4,4}$	0.1	8	64	80	1.00

Next, the products of proportions and covariances may be shown as follows. Each entry is the product of (i) the covariance in the corresponding position in the previous table, (ii) the *x* value of its row, and (iii) the *x* value of its column.

$x_1 x_1 c_{1,1}$	$x_1 x_2 c_{1,2}$	$x_1 x_3 c_{1,3}$	$x_1 x_4 c_{1,4}$	0.64	0.576	3.2	0.16
$x_2 x_1 c_{2,1}$	$x_2 x_2 c_{2,2}$	$x_2 x_3 c_{2,3}$	$x_2 x_4 c_{2,4}$	0.576	5.76	11.52	1.92
$x_3 x_1 c_{3,1}$	$x_2 x_2 c_{3,2}$	$x_3 x_3 c_{3,3}$	$x_3 x_4 c_{3,4}$	3.2	11.52	64.00	3.2
$x_4 x_1 c_{4,1}$	$x_4 x_2 c_{4,2}$	$x_4 x_3 c_{4,3}$	$x_4 x_4 c_{4,4}$	0.16	1.92	3.2	1.00

Finally, all the items in the above table showing the products of proportions and covariances are added and the square root of it is found. This gives

$$[\,112.462\,]^{1/2} = 10.6 \text{ per cent}$$

Efficient Portfolios

The investments available to an investor can be combined into any number of portfolios. Each possible portfolio may be described in terms of its expected rate of return and standard deviation of rate of return and plotted on a two-dimensional graph like the one shown in Exhibit 13.4. The collection of all possible portfolios represents the feasible region which is the shaded region in Exhibit 13.4.

Given the feasible region, which portfolio should the investor choose?

The investor should choose the portfolio that maximises his utility function. This choice involves two steps:

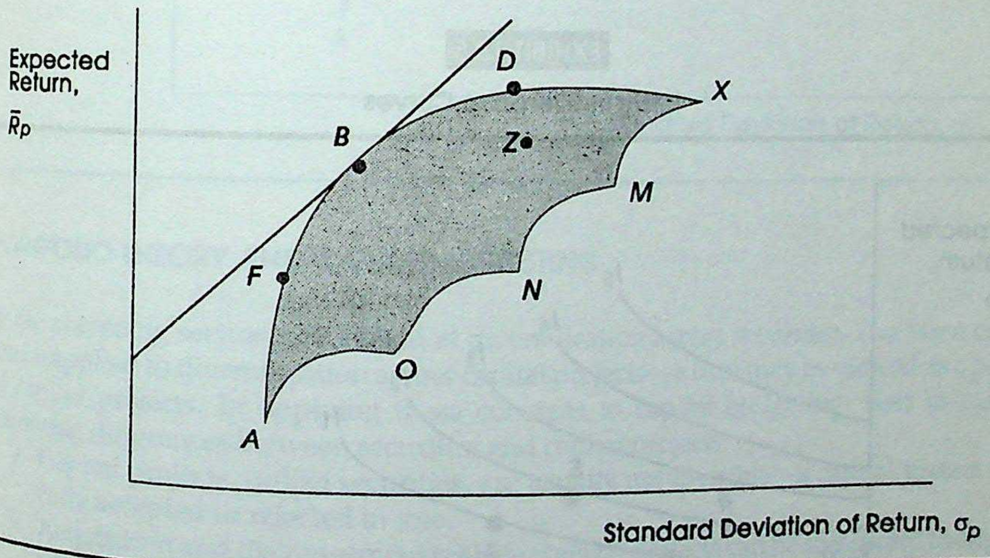
(i) delineation of the set of efficiency portfolios, and

(ii) selection of optimal portfolio from the set of efficient portfolios.

A portfolio is efficient if (and only if) there is no alternative with (i) the same $\overline{R}_p$ and a lower σ_p or (ii) the same σ_p and a higher $\overline{R}_p$ or (iii) a higher $\overline{R}_p$ and a lower σ_p. Thus in Exhibit 13.4, in which the available portfolios are contained in the region *AFXMNO*, only the portfolios which lie along the boundary *AFX* are the portfolios which are efficient—the boundary *AFX* may be referred to as the efficient frontier. All other portfolios are inefficient. A portfolio like Z is inefficient because portfolios like *B* and *D* (among others) dominate it. The efficient frontier is the same for all investors because the portfolio theory is based on the assumption that investors have homogeneous expectations.

EXHIBIT 13.4

Feasible Region



We have merely defined what is meant by a set of efficient portfolios. How can this set be actually obtained from the innumerable portfolio possibilities that lie before the investor? The set of efficient portfolios may be determined with the help of graphical analysis, or calculus analysis, or quadratic programming analysis.[2] The major advantage of graphical analysis is that it is easier to grasp. The disadvantage of graphical analysis is that it cannot handle portfolios containing more than 3 securities.[3] The calculus method can handle portfolios containing any number of securities since mathematical analysis can grapple with the *n*-dimensional space. However, the calculus method is not capable of handling constraints in the form of inequalities. Quadratic programming analysis is the most versatile of all the three approaches. It can handle any number of securities and it can cope with inequalities as well. For practical purposes, the quadratic programming approach is the most useful approach.

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[2] Interested readers may refer to: Jack Clark Francis and Stephen H. Archer, *Portfolio Analysis*, Englewood Cliffs, N.J.: Prentice-Hall, Inc.

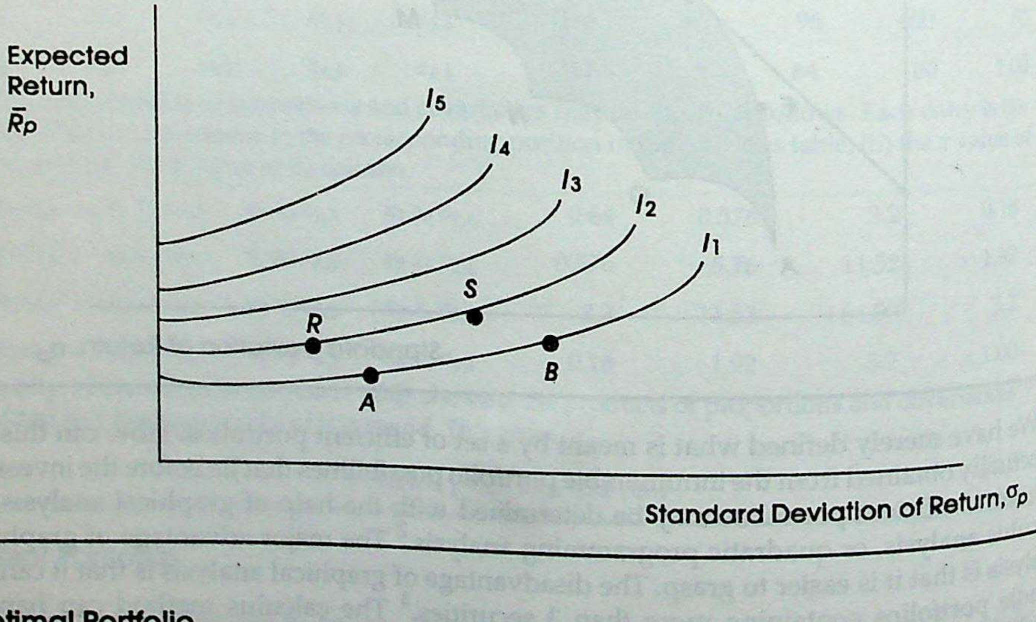
[3] At the most portfolios of 4 securities may be handled if 3-dimensional graphic analysis is used.

Risk-return Preferences

The set of efficient portfolios delineated, the next step is to define the risk-return preferences of the investor. Exhibit 13.5 shows the risk-return indifference curves for a hypothetical investor. In this exhibit, 5 risk-return indifference curves I_1, I_2, I_3, I_4, and I_5 are shown. All the points lying on a given indifference curve offer the same level of satisfaction. For example, points *A* and *B* which lie on the indifference curve I_1 offer the same level of satisfaction; likewise, points *R* and *S*, which lie on the indifference curve I_2 offer the same level of satisfaction. The level of satisfaction increases as one moves leftward. The indifference curve I_2 represents a higher level of satisfaction than the indifference curve I_1, the indifference curve I_3 represents a higher level of satisfaction than the indifference curve I_2, and so on.

EXHIBIT 13.5

Utility Indifference Curves

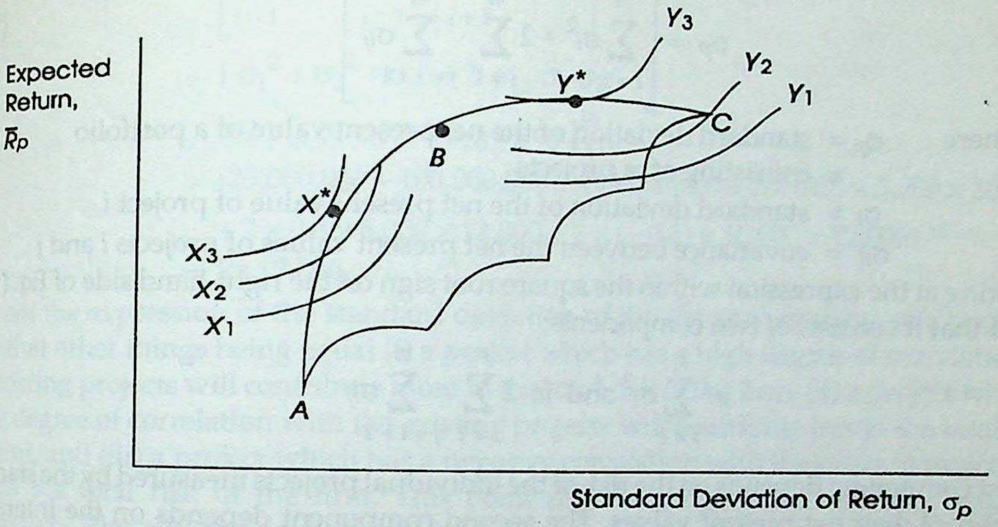


Optimal Portfolio

Given the efficient frontier and the risk-return indifference curves, the optimal portfolio is found at the point of tangency between the efficient frontier and a utility indifference curve. This point represents the highest level of utility the investor can reach. In Exhibit 13.6, two investors *X* and *Y*, confronted with the same efficient frontier, *ABC*, but having differing utility indifference curves (X_1, X_2, and X_3 for X and Y_1, Y_2, and Y_3 for *Y*) are shown as achieving their highest utilities at points X^* and Y^* respectively.

EXHIBIT 13.6

Optimal Portfolio



PORTFOLIO THEORY AND CAPITAL BUDGETING

In the preceding section, we looked at diversification across securities. The same concepts can be applied to diversification across capital projects—a firm may be viewed as a portfolio of capital projects. In applying these concepts to capital budgeting, bear in mind the following differences between securities and capital projects:

- Capital projects, unlike securities, are usually not divisible—a capital project is typically accepted or rejected in toto.
- Acquisition and disinvestment costs for capital projects can be significant though they tend to be negligible for securities.
- In the case of a portfolio of capital projects, issues of mutual exclusiveness and/or dependence are important—these are largely irrelevant in the context of a portfolio of financial securities.
- Capital projects are assessed in terms of net present value whereas financial securities are assessed in terms of rate of return.

Return and Risk of a Portfolio of Capital Projects

Since a capital project has to be accepted or rejected in toto and the criterion of *NPV* satisfies the value additivity principle, the return and risk of a portfolio of capital projects are expressed in Eqs. (13.5) and (13.6).

$$\overline{NPV}_p = \overline{NPV}_1 + \overline{NPV}_2 + \ldots + \overline{NPV}_m \tag{13.5}$$

where $\overline{NPV}_p$ = expected net present value of a portfolio consisting of m projects

$\overline{NPV}_1$ = expected net present value of project 1 in the portfolio

$\overline{NPV}_2$ = expected net present value of project 2 in the portfolio

⋮

$\overline{NPV}_m$ = expected net present value of project m in the portfolio

$$\sigma_p = \left[\sum_{i=1}^{m} \sigma_i^2 + 2 \sum_{i=1}^{m} \sum_{j=i+1}^{m} \sigma_{ij} \right]^{1/2} \tag{13.6}$$

where σ_p = standard deviation of the net present value of a portfolio
= consisting of m projects
σ_i = standard deviation of the net present value of project i
σ_{ij} = covariance between the net present values of projects i and j

Looking at the expression within the square root sign on the right-hand side of Eq. (13.6), we find that it consists of two components:

$$a: \sum_{i=1}^{m} \sigma_i^2 \text{ and } b: 2 \sum_{i=1}^{m} \sum_{j=i+1}^{m} \sigma_{ij}$$

The first component depends on the risk of the individual projects measured by the standard deviation of their net present values. The second component depends on the interaction among the net present values of various projects, measured by the covariances of net present values between projects.

Note that the covariance between the *NPV* of two projects i and j is: $\sigma_{ij} = \rho_{ij}\,\sigma_i\,\sigma_j$. Since the standard deviations (σ_i and σ_j) are always positive, the covariance between the *NPV* of two projects takes the sign of the coefficient of correlation (ρ_{ij}) between them. As the coefficient of correlation can vary between –1 and +1, the covariance can be positive, zero, or negative.

Substituting the expression for covariance given above in Eq. (13.6) we get:

$$\sigma_p = \left[\sum_{i=1}^{m} \sigma_i^2 + 2 \sum_{i=1}^{m} \sum_{j=i+1}^{m} \rho_{ij}\ \sigma_i\,\sigma_j \right]^{1/2}$$

Calculating the expected *NPV* of a portfolio of capital projects is a trivial task. So, skipping that, we will discuss an example showing the calculation of the standard deviation of the portfolio *NPV*.

Example: Bhagya Enterprises has a portfolio of three projects labelled 1, 2, and 3 respectively. The standard deviations of the net present values of these projects are:

$$\sigma_1 = \text{Rs } 5{,}000,\ \sigma_2 = \text{Rs } 10{,}000, \text{ and } \sigma_3 = \text{Rs } 12{,}000.$$

The matrix of correlation among these projects is given below:

$$\begin{array}{cccc} & 1 & 2 & 3 \\ 1 & \rho_{11} = 1.0 & \rho_{12} = 0.8 & \rho_{13} = 0.3 \\ 2 & & \rho_{22} = 1.0 & \rho_{23} = -0.1 \\ 3 & & & \rho_{33} = 1.0 \end{array}$$

Calculate the standard deviation of the net present value of the portfolio of the three projects

$$\sigma_p = \left[\sum_{i=1}^{3} \sigma_i^2 + 2 \sum_{i=1}^{3} \sum_{j=i+1}^{3} \rho_{ij}\, \sigma_i\, \sigma_j \right]^{1/2}$$

$$= [\, \sigma_1{}^2 + \sigma_2{}^2 + \sigma_3{}^2 + 2\ \rho_{12}\, \sigma_1\, \sigma_2$$

$$+ 2\, \rho_{13}\, \sigma_1\, \sigma_3\ + 2\, \rho_{23}\, \sigma_2\, \sigma_3\ ]^{1/2}$$

$$= (25{,}000{,}000 + 100{,}000{,}000 + 144{,}000{,}000 + 2 \times 0.08 \times 5{,}000 \times 10{,}000$$

$$+ 2 \times 0.3 \times 5{,}000 \times 12{,}000 + 2 \times (-\,0.1) \times 10{,}000 \times 12{,}000)^{1/2}$$

$$= \text{Rs } 17{,}000$$

From the expression of the standard deviation of the net present value of a project it is clear that other things being equal (i) a project which has a high degree of correlation with the existing projects will contribute more to the total risk of the firm, (ii) a project which has a low degree of correlation with the existing projects will contribute less to the total risk of the firm, and (iii) a project which has a negative correlation with the existing projects may reduce the total risk of the firm. This point may be emphasised with the help of an illustration. The existing investments of a firm are projects 1 and 2 with the following characteristics:

$$\sigma_1 = 10{,}000,\ \sigma_2 = 8{,}000,\ \text{and}\ \rho_{12} = 0.5$$

The firm is considering three new projects labelled 3, 4, and 5 respectively. The standard deviation of the net present value of these investments is the same:

$$\sigma_3 = \sigma_4 = \sigma_5 = \text{Rs } 15{,}000.$$

The coefficients of correlation between these proposed investments and the existing investments are as follows:

	1	2
3	$\rho_{31} = 0.6$	$\rho_{32} = 0.8$
4	$\rho_{41} = 0.05$	$\rho_{42} = 0$
5	$\rho_{51} = -\,0.6$	$\rho_{52} = -\,0.7$

The standard deviation of the net present value of several portfolios is shown below:

Portfolio	Rs
A (consisting of 1 and 2)	15,625
B (consisting of 1, 2 and 3)	29,000
C (consisting of 1, 2 and 4)	22,000
D (consisting of 1, 2 and 5)	11,000

It is evident that (i) when project 3 (a project whose net present value is highly positively correlated with the net present value of existing projects) is added to the existing projects, risk increases substantially, (ii) when project 4 (a project whose net present value is moderately correlated or uncorrelated with the net present value of existing projects) is added risk increases moderately, and (iii) when project 5 (a project whose net present value is highly negatively correlated with the net present value of existing projects) is added risk declines significantly.

Coefficient of Correlation Between Projects

The coefficient of correlation, ρ_{ij}, between the net present values of projects i and j may vary between –1 and +1. A value of –1 means that the net present values of the two projects are perfectly negatively correlated—this means that they vary inversely. A value of +1 means that the net present values of the two projects are perfectly positively correlated—this means that they vary directly in the same proportional manner.

Typically, the value of ρ_{ij} for a pair of projects is between 0 and 1.00 because the returns of most of the projects are influenced by the broad movements in the economy. Projects in unrelated industries like cotton textiles and cement are likely to have a low ρ_{ij} value and projects which are in related industries like steel and cement are likely to have a high ρ_{ij} value. The estimates of ρ_{ij} must be made carefully because they are very important inputs in the calculation of portfolio standard deviation.

Efficient Frontier

Using the above procedures, we can calculate the expected net present value and standard deviation of net present value for various feasible combinations of projects. A feasible combination consists of the existing projects plus one or more of the new projects being considered. Naturally, in a feasible combination we cannot have two projects which are mutually exclusive. Further, if two or more projects are complementary in nature, the complementary projects go together as a unit. (They are included or dropped in toto.)

The mean and standard deviation of net present value (the basic parameters) for various feasible combinations may be plotted on a scatter diagram like the one shown in Exhibit 13.7. In this exhibit certain points dominate others because they represent higher expected net present value, given a certain level of standard deviation, or a lower standard deviation, given a certain level of net present value, or a higher expected net present value and a lower standard deviation of net present value. For example, point *H* dominates point *F* because for the same level of standard deviation of net present value, *H* has a higher expected net present value in comparison with *F*; point *G* dominates point *M* because *G* in comparison with *M* has the same expected net present value with a lower standard deviation of net present value; point *L* dominates point *K* because it has a higher expected net present value and a lower standard deviation of *NPV*. The points that dominate others lie on the left edge of the feasible region and represent the efficient frontier.

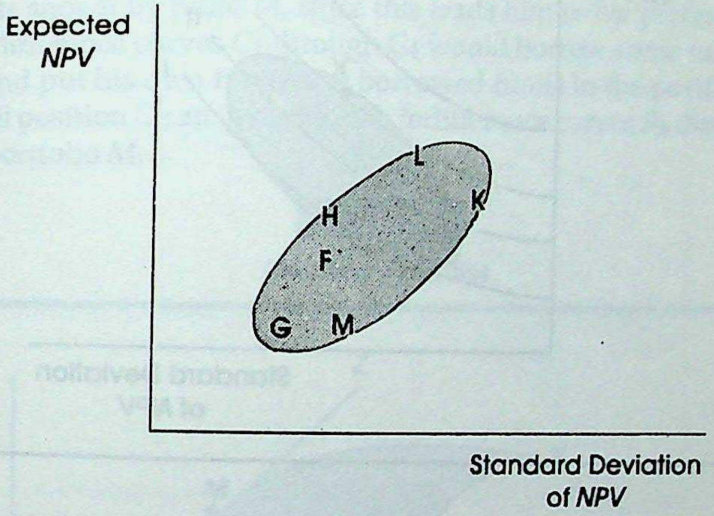
Optimal Portfolio

Once the efficient frontier is delineated, the optimal portfolio on the efficient frontier can be obtained if the utility function of management is specified over the two parameters, expected net present value and standard deviation of net present value. If the utility indifference curves of management are as shown in Exhibit 13.8, the optimal portfolio is *X*. *X* is the optimal portfolio because it enables management to achieve the highest level of attainable utility level. It may be noted that the utility indifference curve II provides a higher level of satisfaction than utility indifference curve I. Likewise, the utility indifference curve III provides a higher level of satisfaction than the utility indifference curve II, so on and so forth.

Put differently, as we move to the left in Exhibit 13.8 each successive utility indifference curve means a higher level of utility.

EXHIBIT 13.7

Expected *NPV* and Standard Deviation of *NPV*



It may be argued that in practice it is difficult to obtain the utility indifference functions for management and hence it is almost impossible to determine the optimal portfolio. While this argument has some substance, remember that a plotting of various feasible portfolios on a graph like that shown in Exhibit 13.7 is immensely helpful in facilitating decisions. Such a graph narrows down the range of choice considerably and from the small set on the efficient frontier, the management can select what it considers to be the most desirable portfolio. The selection of the portfolio deemed to be most desirable determines the new projects to be undertaken.

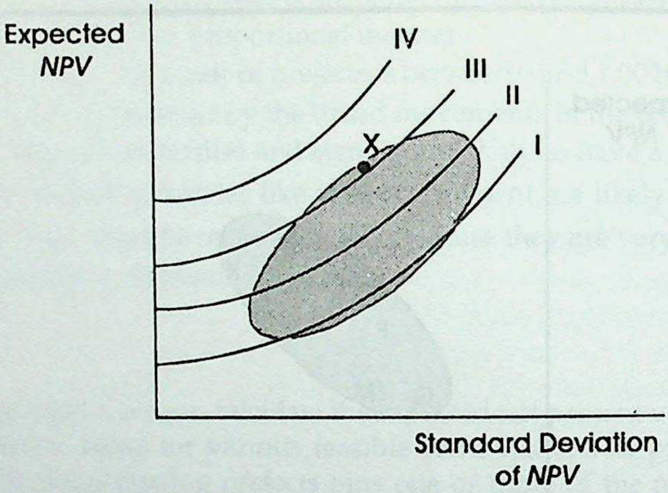
CAPITAL ASSET PRICING MODEL

The capital asset pricing model (CAPM, hereafter), an exercise in positive economics, is concerned with two sets of questions:

I (a) What is the appropriate measure of risk for an efficient portfolio?
(b) What is the relationship between risk and return for efficient portfolios?
II (a) What is the appropriate measure of risk for an individual security or an inefficient portfolio?
(b) What is the relationship between risk and return for an individual security or an inefficient portfolio?

EXHIBIT 13.8

Utility Indifference Curves



Assumptions

The standard CAPM is based on the following assumptions:

- Individuals are risk-averse.
- Individuals seek to maximise the expected utility of their portfolios over a single period planning horizon.
- Individuals have homogeneous expectations—they have identical subjective estimates of the means, variances, and covariances among returns.
- Individuals can borrow and lend freely at the riskless rate of interest.
- The market is perfect: there are no taxes; there are no transaction costs; securities are completely divisible; the market is competitive.
- The quantity of risky securities in the market is given.

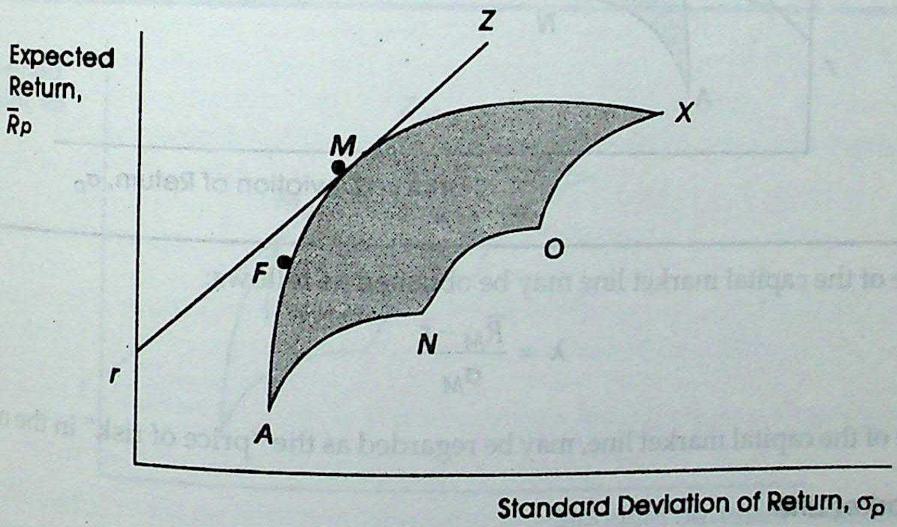
Looking at these assumptions, one may feel that the CAPM is unrealistic. However, the value of a model depends not on the realism of its assumptions but on the validity of its conclusions. Extensive empirical analysis suggests that the conclusions of the capital asset pricing model are reasonably valid—it is considered by many as one of the most robust economic models.

Capital Market Line

An important assumption of CAPM is that the investor can borrow or lend freely at the risk-free rate of interest. This means that the investors would be interested only in that portfolio of risky investments at which the line from the point representing the risk-free investment is tangential to the feasible region of risky portfolios. This is clarified graphically in Exhibit 13.9. In this exhibit the shaded region represents the feasible region of risky investments, point r represents the risk-free investment, and point M represents the point at which the straight line from r is tangential to the feasible region of risky investments. By a suitable combination of r and M the investor can reach any point along rMZ. Since rMZ, with the exception of point M which rMZ has in common with AFX, dominates the frontier AFX, all investors would hold a portfolio consisting of r and M in some combination. Exhibit 13.10 shows, by way of illustration, what investors with differing risk attitudes would do. An investor with risk-return preferences reflected by indifference curves A_1 through A_4 would lend a part of his funds at the risk-free rate of return and invest the balance in the portfolio of assets shown by point M, since this leads him to his preferred position A^*; an investor with indifference curves C_1 through C_4 would borrow some funds at the risk-free rate of interest and put his own funds and borrowed funds in the portfolio M to reach his preferred over-all position C^*; an investor with indifference curves B_1 through B_4 would put all his funds in portfolio M.

EXHIBIT 13.9

Efficiency Frontier


Z
Expected Return, $\overline{R}_p$
X
M
O
F
N
r
A
Standard Deviation of Return, σ_p

Since every investor wishes to hold the risky portfolio, M, this portfolio, in order for the market to be in equilibrium, must represent the totality of risky securities in the market. If some security were not in M, its price would fall making its expected return higher. As a result, it would become more attractive and get included in M. As M represents the totality of risky securities in the market place, the proportion in market value terms, of each security in M is equal to the proportion of its value to the total value of risky securities.

The straight line passing through r and M is the capital market line. It can be expressed as:

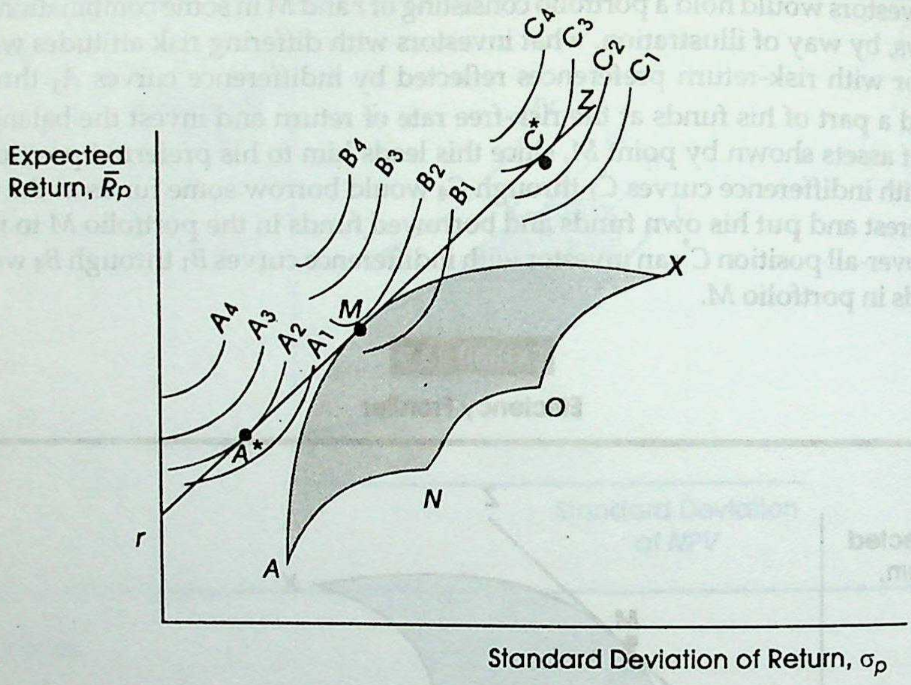
$$\overline{R}_j = r + \lambda \sigma_j \qquad (13.7)$$

where

$\overline{R}_j$ = expected return on a portfolio j held by investors
r = risk-free rate of interest
λ = slope of the capital market line
σ_j = standard deviation of the return on portfolio j.

EXHIBIT 13.10

Portfolio Choices of Investors



The slope of the capital market line may be obtained as follows:

$$\lambda = \frac{\overline{R}_M - r}{\sigma_M} \tag{13.8}$$

The slope of the capital market line, may be regarded as the "price of risk" in the market.

Security Market Line

The capital market line reflects the relationship between risk and return for efficient portfolios, but it does not spell out the relationship between risk and return for inefficient assets, either individual securities or portfolios. The relationship between risk and return for an inefficient portfolio or a single security is expressed by the security market line:

$$\overline{R}_i = r + (\overline{R}_M - r)\,\frac{C_{iM}}{\sigma_M^2} \tag{13.9}$$

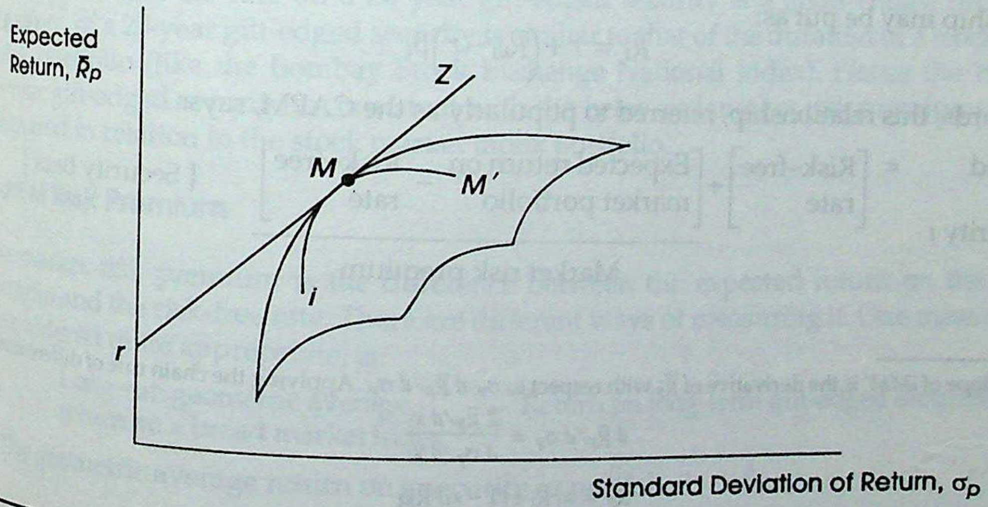
where $\overline{R}_i$ = expected return on security i
r = risk-free rate of return
$\overline{R}_M$ = expected return on market portfolio
$\sigma_M{}^2$ = variance of return on market portfolio
C_{iM} = covariance of return between security i and market portfolio

Derivation of the Security Market Line

The expected return and standard deviation values associated with single securities will normally lie below the capital market line, since undiversified holdings are usually inefficient. Such points may be found throughout the feasible region with no consistent relationship between expected return and standard deviation. Exhibit 13.11 shows the typical relationship between a single security (point *i*) and the market portfolio (*M*). The curve *iMM′* indicates all R_p and σ_p obtainable by various feasible combinations of *i* and *M*. The proportion of *i* is denoted by X_i and the proportion of *M* by X_M. $X_i = 1$ indicates 100 per cent investment in *i* and $X_m = 1$ indicates 100 per cent investment in *M*. Note that $X_M = 1$ implies that some funds are invested in *i* since *i* is included in portfolio *M*. This means that a combination in which *i* is not found at all must have some negative value of X_i. Point *M′* represents such a combination.

EXHIBIT 13.11

Relationship Between a Single Security and Market Portfolio


Expected Return, $\bar{R}_p$
Z
M
M′
i
r
Standard Deviation of Return, σ_p

The curve *iMM′* in Exhibit 13.11 is tangential to the capital market line *rMZ* at *M*. All such curves are tangential to the capital market line in equilibrium. Such curves cannot intersect *rMZ* (i.e., fail to be tangential to *rMZ*) because this would mean that some feasible combination of assets lies to the left of the capital market line, an impossibility since the capital market line represents the efficient frontier. This fact means that the slope of *iMM′* at point *M* is equal to the slope of the capital market line.

The slope of *iMM′* at point *M* is equal to:

$$S_M = \frac{(\overline{R}_i - \overline{R}_M)\,\sigma_M}{C_{iM} - \sigma_M^{\,2}} \qquad (13.10)^{4}$$

where S_M = slope of *iMM′* at point *M*
$\overline{R}_i$ = expected return on security *i*
$\overline{R}_M$ = expected return on market portfolio
σ_M = standard deviation of the return on market portfolio
C_{iM} = covariance of return between security *i* and market portfolio

Since the slope of *iMM′* at *M* is equal to the slope of the capital market line, we get

$$\frac{(\overline{R}_i - \overline{R}_M)\,\sigma_M}{C_{iM} - \sigma_M^{\,2}} = \frac{\overline{R}_M - r}{\sigma_M} \qquad (13.11)$$

Simplifying and re-arranging we get:

$$\overline{R}_i = r + \left(\frac{\overline{R}_M - r}{\sigma_M^{\,2}}\right) C_{iM} \qquad (13.12)$$

Since $C_{iM}/\sigma_M^{\,2}$ in Eq. (13.12) is the slope of a simple regression of R_i over R_M, the above relationship may be put as:

$$\overline{R}_i = r + \left(\overline{R}_m - r\right)\beta_i \qquad (13.13)$$

In words, this relationship, referred to popularly as the CAPM, says:

$$\begin{array}{l}\text{Expected}\\ \text{return}\\ \text{on security } i\end{array} = \left[\begin{array}{l}\text{Risk–free}\\ \text{rate}\end{array}\right] + \underbrace{\left[\begin{array}{l}\text{Expected return on}\\ \text{market portfolio}\end{array} - \begin{array}{l}\text{Risk–free}\\ \text{rate}\end{array}\right]}_{\text{Market risk premium}} \quad [\text{ Security beta }]$$

---

[4] The slope of *iMM′* is the derivative of $\overline{R}_p$ with respect to σ_p, $d\,\overline{R}_p/d\,\sigma_p$. Applying the chain rule of differentiation

$$d\,\overline{R}_p/d\,\sigma_p = \frac{d\,\overline{R}_p/d\,x_i}{d\,\sigma_p/d\,x_i} \qquad (1)$$

Now
$$\overline{R}_p = x_i\,\overline{R}_i + (1 - x_i)\,\overline{R}_M. \qquad (2)$$

So
$$d\,\overline{R}_p/d\,x_i = \overline{R}_i - \overline{R}_M \qquad (3)$$

Further
$$\sigma_p = [\,x_i^2\,\sigma_i^{\,2} + (1 - x_i)^2\,\sigma_M^{\,2} + 2\,x_i\,(1 - x_i)\,C_{iM}\,]^{1/2} \qquad (4)$$

So
$$\frac{d\,\sigma_p}{d\,x_i} = \frac{x_i\,(\sigma_i^2 + \sigma_M^{\,2} - 2\,C_{iM}) + C_{iM} - \sigma_M^{\,2}}{\sigma_p} \qquad (5)$$

Substituting the results of (3) and (5) in (1), we get

$$\frac{d\,\overline{R}_p}{d\,\sigma_p} = \frac{(\overline{R}_i - \overline{R}_M)\,\sigma_p}{x_i\,(\sigma_i^2 + \sigma_M^{\,2} - 2\,C_{iM}) + C_{iM} - \sigma_M^{\,2}} \qquad (6)$$

Evaluating $d\,\overline{R}_p/d\,\sigma_p$ at point *M* where $x_i = 0$, we get

$$\left(\frac{d\,\overline{R}_p}{d\,\sigma_p}\right)_{x_i = 0} = \frac{(\overline{R}_i - \overline{R}_M)\,\sigma_M}{C_{iM} - \sigma_M^{\,2}} \qquad (7)$$

This is the slope at *M*, S_M, referred to above.

ESTIMATION OF THE KEY FACTORS

To apply the CAPM, you need estimates of the following factors that determine the CAPM line:

- Risk-free rate
- Market risk premium
- Beta

Risk-free Rate

The risk-free rate is the return on a security (or portfolio of securities) that is free from default risk and is uncorrelated with returns from anything else in the economy. Theoretically, the return on a zero-beta portfolio is the best estimate of the risk-free rate. Constructing zero-beta portfolios, however, is costly and complex. Hence, they are often unavailable for estimating the risk-free rate.

Some practical alternatives for determining the risk-free rate are: (i) the rate on a 364-day Treasury bill, (ii) the rate on a 10-year gilt-edged security, and (iii) the rate on a 20-year gilt-edged security.

It appears that the rate on a 20 year gilt-edged security is a good choice because the duration[5] of a 20-year gilt-edged security is similar to that of the duration of a stock market index portfolio (like the Bombay Stock Exchange National Index). Hence the rate on a 20-year gilt-edged security is consistent with the betas and market risk premiums that are estimated in relation to the stock market index portfolio.

Market Risk Premium

The market risk premium is the difference between the expected return on the market portfolio and the risk-free rate. There are different ways of measuring it. One measure, that is considered quite appropriate, is:

$$\text{Long-run geometric average return on a broad market index} - \text{Return on long-term gilt-edged securities}$$

The geometric average return on a security or portfolio is defined as:

$$\left[(1+r_1)(1+r_2)\ (1+r_3)\ldots(1+r_n)\right]^{1/n}-1 \qquad (13.14)$$

where r_1 = return[6] for year 1

r_2 = return for year 2

---

[5] The duration represents the average life of an instrument.

[6] The return on a security (or portfolio) for a given period is:

$$\frac{\text{Income during the period} + [\text{Ending price} - \text{Beginning price}]}{\text{Beginning price}}$$

To illustrate, consider the following information about a certain equity share:

Price at the beginning of the year	: Rs 60.00
Dividend received at the end of the year	: Rs 2.40
Price at the end of the year	: Rs 66.00

The return on this share is: $\dfrac{2.40 + (66.00 - 60.00)}{60.00} = 0.14$ or 14 per cent

$\vdots$

r_n = return for year n

For example, if the annual returns for years 1, 2, 3, 4, and 5 are 15 per cent, 0 per cent, 36.4 per cent, 26.7 per cent, and 15.7 per cent respectively, the geometric average return over the 5 year period is:

$$[(1+0.15)(1+0.00)(1+0.364)(1+0.267)(1+0.157)]^{1/5}-1$$
$$= 0.18 \text{ or 18 per cent.}$$

The reasons for measuring the market risk premium as the difference between the long-run geometric average return on a broad market index and the return on long-term gilt-edged securities are as follows:

1. A long time frame eliminates the effects of short-term aberrations and anomalies.
2. The geometric average is superior to the arithmetic average as it is not biased by the measurement period.
3. Since the geometric average represents the compound rate of return that equates the beginning and ending value, it is a better estimate of the expectations of investors over long periods of time.
4. Calculating the premium over long-term return on gilt-edged securities is consistent with the way in which the risk-free rate is defined.

Beta

The beta of an investment j is the slope of the following regression relationship:

$$R_{jt} = a_j + \beta_j R_{mt} + e_{jt} \qquad (13.15)^7$$

where R_{jt} = return on investment j (a project or a security) in period t
R_{mt} = return on the market portfolio in period t
α_j = intercept of the linear regression relationship between
= R_{jt} and R_{mt} (α is pronounced as alpha)
β_j = slope of the linear regression relationship between R_{jt} and R_{mt} (β is pronounced as beta)

The variance of R_{jt} as per Eq. (13.15) is:

---

[7] In this regression model, the following properties are usually assigned to the error term e_{jt}. It has an expected value of zero and a finite variance:

$$E\ (e_{jt}) = 0$$

$$\text{Var}(e_{jt}) = Q^2 \text{ (a finite term)}$$

It is not correlated with the return on the market portfolio:

$$\text{Cov}\ (e_{jt}, R_{mt}) = 0$$

It is not serially correlated over time:

$$\text{Cov}\ (e_{jt}, e_{j,t+n}) = 0 \text{ for all values of } n$$

In addition to these assumptions, commonly made in regression models, the capital asset pricing model is based on the assumption that the error term for project j is not correlated with the error term for any other project. This means:

$$\text{Cov}\ (e_{it}, e_{jt}) = 0$$

$$\text{Var}(R_{jt}) = \beta_j^2 \sigma_M^2 + \text{Var}(e_{jt}) \qquad (13.16)^8$$

Examining Eq.(13.16), we find that the total risk associated with investment *j* as measured by its variance is the sum of two components: (i) The risk associated with the responsiveness of the return of the investment to market index: $\beta_j^2 \sigma_m^2$ and (ii) The risk associated with the error term: Var (e_{jt}). The first component represents systematic risk and the second, unsystematic risk. Systematic risk stems from economy-wide factors which have a bearing on the fortune of all firms whereas unsystematic risk emanates from firm-specific factors. While systemaic risk cannot be diversified away, unsystematic risk can be. Hence, the relevant risk, as per the capital asset pricing model, is the systematic risk. It is also referred to as non-diversifiable risk.

To measure the systematic risk of a project, we have to calculate the slope of the regression Eq. (13.15). The estimate of the slope of the regression model is:

$$\beta_j = \frac{\rho_{jm}\,\sigma_j\,\sigma_m}{\sigma_m^2} \qquad (13.17)$$

where β_j = estimate of the slope in the regression model

ρ_{jm} = coefficient of correlation between the return on investment *j* and the return on investment *m*

σ_j = standard deviation of the return on investment *j*

σ_m = standard deviation of the return on market portfolio.

The calculation of beta may be illustrated with an example. The rates of return on stock *A* and the market portfolio for 15 periods are given below:

Period	Return on stock A(%)	Return on market portfolio (%)	Period	Return on stock A(%)	Return on market portfolio (%)
1	10	12	9	−9	1
2	15	14	10	14	12
3	18	13	11	15	−11
4	14	10	12	14	16
5	16	9	13	6	8
6	16	13	14	7	7
7	18	14	15	−8	10
8	4	7			

---

[8] Eq. (13.16) is derived as follows:

$$\begin{aligned}
\text{Var}(R_{jt}) &= \text{Var}(\alpha_j + \beta_j R_{mt} + e_{jt}) = E\left[(\alpha_j + \beta_j R_{mt} + e_{jt}) - E(\alpha_j + \beta_j R_{mt} + e_{jt})\right]^2 \\
&= E\left[\alpha_j + \beta_j R_{mt} + e_{jt} - \alpha_j - \beta_j E(R_{mt})\right]^2 = E\left[\beta_j (R_{mt} - E(R_{mt})) + e_{jt}\right]^2 \\
&= E\left[\beta_j^2 (R_{mt} - E(R_{mt}))^2 + e_{jt}^2 + 2\beta_j (R_{mt} - E(R_{mt}))\, e_{jt}\right] \\
&= E(\beta_j)^2 E(R_{mt} - E(R_{mt}))^2 + E(e_{jt}^2) + 2E(\beta_j)\, E(R_{mt} - E(R_{mt}))\, E(e_{jt}) \\
&= \beta_j^2 \sigma_m^2 + \text{Var}(e_{jt}) + 0 = \beta_j^2 \sigma_m^2 + \text{Var}(e_{jt})
\end{aligned}$$

EXHIBIT 13.12

Calculation of Beta

Period	Return on stock A, R_A	Return on market portfolio, R_M	Deviation of return on stock A from its mean, $(R_A - \overline{R}_A)$	Deviation of return on market portfolio from its mean $(R_M - \overline{R}_M)$	Product of the deviation, $(R_A - \overline{R}_A)$ $(R_M - \overline{R}_M)$	Square of the deviation of return on market portfolio from its mean $(R_M - \overline{R}_M)^2$
1	10	12	0	3	0	9
2	15	14	5	5	25	25
3	18	13	8	4	32	16
4	14	10	4	1	4	1
5	16	9	6	0	0	0
6	16	13	6	4	24	16
7	18	14	8	5	40	25
8	4	7	−6	−2	12	4
9	−9	1	−19	−8	152	64
10	14	12	4	3	12	9
11	15	−11	5	−20	−100	400
12	14	16	4	7	28	49
13	6	8	−4	−1	4	1
14	7	7	−3	−2	6	4
15	−8	10	−18	1	−18	1
	$\sum R_A = 150$ $\overline{R}_A = 10$	$\sum R_M = 135$ $\overline{R}_M = 9$			$\sum (R_A - \overline{R}_A)$ $(R_M - \overline{R}_M)$ $= 221$	$\sum (R_M - \overline{R}_M)^2$ $= 624$

What is the beta for stock A? The beta of stock A is equal to:

$$\frac{\text{Cov}\,(R_A, R_M)}{\sigma_M^{\;2}}$$

The calculation of the numerator and the denominator of this ratio is shown in Exhibit 13.12.

$$\text{Cov}\,(R_A, R_M) = \frac{\sum (R_A - \overline{R}_A)(R_M - \overline{R}_M)}{n} = \frac{221}{15} = 14.73$$

$$\sigma_M^{\;2} = \frac{\sum (R_M - \overline{R}_M)^2}{n} = \frac{624}{15} = 41.6$$

So, the beta for stock A is

$$\frac{14.73}{41.6} = 0.354$$

Adjusting Historical Beta

The beta calculated above reflects a measure of historical alignment of the price of a stock with that of the market. Hence many regard it as a "measurement" of past relationship that cannot be naively used as an "estimate" of future risk. Why? Two reasons are commonly given:

1. The historial alignment may have been significantly influenced by chance factors.
2. A company's beta may change over time.

To overcome these limitations, some adjustment may be required. A procedure that is sometimes recommended is to take a weighted average of the historical beta, on the one hand, and 1.0 (the value of market beta) on the other. The weighting scheme should take into account the degree of historical estimation error and the dispersion of individual firms around the average. If the historical estimation error is large, the weight assigned to the historical beta should be small. If the dispersion of individual firms around the average is large, the weight assigned to 1.00 (the market beta) should be small. By balancing these factors, a suitable weighting scheme can be developed. Note that Merill Lynch, in its beta prediction, assigns a weight of 0.66 to historical beta and a weight of 0.34 to average value (see Merill Lynch's booklet *Security Risk Evaluation Service*).

Betas Based on Fundamental Information

Can fundamental information be used for predicting betas? Based on the research done by Rosenberg and others, the answer seems to be "yes". Applying complex econometric analysis, Rosenberg and others have devised methods for predicting betas largely on the basis of the fundamental operating and financial characteristics of the company. The key fundamental factors employed by them for predicting betas are given below:

Industry affiliation Betas vary significantly across industries. These differences are primarily attributable to variations in business risks across industries.

Corporate growth Corporate growth and beta are correlated. The stronger the growth orientation, the higher the beta is likely to be.

Earnings variability The greater the variability of earnings over time, the higher the beta is likely to be.

Financial leverage The greater the financial leverage, the higher the beta is likely to be.

Size The larger the size of a company, the smaller the beta is likely to be.

From the point of view of the corporate finance manager, fundamental betas have several advantages over historical (market-generated) betas:

- Fundamental betas have a stronger intuitive appeal as the rules for predicting them are consistent with our general understanding of what makes a company risky.
- Fundamental betas are ideal for the analysis of non-trading assets like individual projects, strategic business units, and corporate divisions as price behaviour for such assets is not available.
- Fundamental betas, in general, seem to outperform historical betas.
- Fundamental betas can be based on future descriptors, whereas historical betas necessarily require past data (for example, a firm's growth orientation can be estimated using revenue projections)

CAPITAL ASSET PRICING MODEL AND CAPITAL BUDGETING

You can apply the capital asset pricing model to figure out a project's required rate of return. Before we discuss the procedure to do this, it is helpful to understand the link between equity beta and asset beta.

Equity Beta and Asset Beta

To explore the relationship between equity beta and asset beta, we will initially ignore taxes.

Look at Zenith Limited which has the following balance sheet:

Equity	: 50	Assets	: 100
Debt	: 50		

If you buy all the securities of Zenith (its entire equity as well as debt), you will own all its assets. So the beta of your portfolio (β_P) of Zenith's securities is equal to the beta of Zenith's assets (β_A).

$$\beta_P = \beta_A \tag{13.18}$$

Now, the beta of your portfolio is simply the weighted arithmetic average of the betas of its components, viz., equity (E) and debt (D).

$$\beta_P = \beta_E \frac{E}{E+D} + \beta_D \frac{D}{E+D} \tag{13.19}$$

Hence

$$\beta_A = \beta_E \frac{E}{E+D} + \beta_D \frac{D}{E+D} \tag{13.20}$$

Juggling Eq. (13.20) a bit, you get:

$$\beta_E = \beta_A + (\beta_A - \beta_D) \frac{D}{E} \tag{13.21}$$

If the beta of debt, β_D, is assumed to be zero (this means that debt is considered to be risk-free)[9]

$$\beta_E = \beta_A + \beta_A \frac{D}{E} = \beta_A \left[1 + \frac{D}{E}\right] \tag{13.22}$$

So far we assumed that taxes don't exist. What happens in a world of taxes[10] where interest on debt is a tax-deductible expense? In this case, as Robert Hamada[11] and others have shown

$$\beta_E = \beta_A \left[1 + \frac{D}{E}(1 - T)\right] \tag{13.23}$$

This means

$$\beta_A = \frac{\beta_E}{\left[1 + \frac{D}{E}(1 - T)\right]} \tag*{(13.24)[12]}$$

Eqs. (13.23) and (13.24) show how equity beta and asset beta are related.

Procedure for Calculating a Project's Required Rate of Return

The procedure for calculating a project's required rate of return, as per the capital asset pricing model, involves the following steps.

Step 1: Find a sample of firms engaged in the same line of business If a firm is considering a project for manufacturing a certain product, identify a sample of firms which are engaged wholly or largely in the manufacture of that product.

Step 2: Obtain equity betas for the sample firms To calculate the equity beta of a firm, employ the procedure discussed earlier. Regress the monthly return of the equity stock of the firm on the monthly return of the market portfolio for 50 to 60 months. Where 50 to 60 observations of monthly returns are not available, you may use 50-60 observations of fortnightly returns.

Step 3: Derive asset betas after adjusting equity betas for financial leverage For each firm in the sample, the asset beta can be derived from its equity beta using the following relationship:

$$\beta_A = \frac{\beta_E}{\left[1 + \frac{D}{E}(1 - T)\right]} \tag{13.24}$$

Step 4: Find the average of the asset betas Once the asset betas for the sample firms are obtained, the average can be readily calculated.

Step 5 Figure out the equity beta for the proposed project The equity beta for the proposed project can be derived by adjusting the average asset beta (obtained in the previous step) for the financial leverage planned for the project. Remember the formula:

$$\beta_E = \beta_A \left[1 + \frac{D}{E}(1 - T)\right]. \tag{13.23}$$

---

[9] This is a reasonable assumption for the debt of financially strong companies.

[10] This, indeed, is a more realistic representation of the real world.

[11] Robert Hamada, "Portfolio Analysis, Market Equilibrium, and Corporate Finance", *Journal of Finance*, March 1969.

[12] In Eq. (13.24), T stands for the tax rate.

Step 6: Estimate the cost of equity for the proposed project As per the capital asset pricing model, the cost of equity for the proposed project is

$$K_e = r + (\overline{R}_M - r)\,\beta_E \tag{13.25}$$

Step 7: Calculate the project's required rate of return The project's required rate of return or its weighted average cost of capital will be:

$$K_a = W_e\,K_e + W_d\,K_d\,(I - T) \tag{13.26}$$

where K_a = weighted average cost of capital
W_e = weight associated with equity $(E/E{+}D)$
K_e = cost of equity
W_d = weight associated with debt $(D/E{+}D)$
K_d = pre-tax cost of debt
I = tax rate

Illustration

Diversified Limited is evaluating a granite project for which it proposes to use a debt-equity ratio of 1.5:1. The pre-tax cost of debt is 15 per cent and the tax rate is expected to be 30 per cent. The risk-free rate is 12 per cent and the expected return on the market portfolio is 16 per cent. The project's required rate of return may be calculated as follows:

Step 1: Find a sample of firms engaged in similar business According to the chief executive of Diversified Limited the following firms are engaged wholly in the same line of business:

1. Ankit Granites Limited
2. Bharath Granites Company
3. Modern Granites Limited

Step 2: Obtain equity betas for the sample of comparable firms The equity betas of the three firms, obtained by regressing their equity returns on the returns of the market portfolio for the past 60 months, are as follows

Ankit Granites Limited	: 1.20
Bharath Granites Company	: 1.10
Modern Granites Limited	: 1.05

Step 3: Derive asset betas after adjusting equity betas for financial leverage The debt-equity ratios for the three firms, namely, Ankit Granites Limited, Bharath Granites Company, and Modern Granites Limited are 2.1, 1.8, and 1.3 respectively. The effective tax rate for all of them is 40 per cent. Their asset betas are derived by using the formula:

$$\beta_A = \beta_E / \,[1 + D/E\,(1 - T)]$$

Ankit Granites Ltd : $\dfrac{1.20}{[\,1 + 2.1\ (0.6)\,]} = 0.53$

Bharath Granites Co : $\dfrac{1.10}{[\,1 + 1.6\ (0.6)\,]} = 0.56$

Modern Granites Ltd : $\dfrac{1.05}{[\,1 + 1.3\ (0.6)\,]} = 0.59$

Step 4: Find the average of asset betas The average of asset betas of Ankit Granites Limited, Bharath Granites Company, and Modern Granites Limited is:

$$\frac{0.53 + 0.56 + 0.69}{3} = 0.56$$

Step 5: Figure out the equity beta for the proposed project The equity beta for the proposed project is:

$$\beta_E = \beta_A \; [1 + D/E\,(1 - T)]$$

$$= 0.56\,[1 + 1.5(1 - .3)] = 1.148$$

Step 6: Estimate the cost of equity for the proposed project As per the capital asset pricing model, the cost of equity for the proposed project is:

$$K_e = r + (\overline{R}_M - R_F)\,\beta_E$$

$$= .12 + (.16 - .12)\,1.148 = .166$$

Step 7: Calculate the project's required rate of return The weighted average cost of capital (the required rate of return) for the granite project of Diversified Limited is:

$$K_a = W_e K_e + W_d K_d \; (1 - T)$$

$$= \left[\frac{1}{2.5}\right] (0.166) + \left[\frac{1.5}{2.5}\right] (0.15)\,(0.7)$$

$$= .1294 = 12.94 \text{ per cent}$$

SUMMARY

- A portfolio is a combination of assets. Portfolio theory shows how an individual can reach his optimal portfolio position. Originally proposed by Harry Markowitz, portfolio theory is based on the assumption that the utility of an investor is a function of two factors: mean (or expected) return and variance (or its square root, the standard deviation) of return.
- The expected return on a portfolio consisting of *n* securities is: $\overline{R}_p = \sum x_i \overline{R}_i$.
- The variance of the return on a 2-security portfolio is:

$$\sigma_p^2 = x_1^2 \sigma_1^2 + x_2^2 \sigma_2^2 + 2\,x_1\,x_2\,\rho_{12}\,\sigma_1\,\sigma_2$$

- The variance of the return on an *n*-security portfolio is: $\sigma_p^2 = \sum \sum x_i\, x_j\, \rho_{ij}\, \sigma_i\, \sigma_j$
- The investments available to an investor may be combined into any number of portfolios.
- The investor should choose the portfolio that maximises his utility function. This involves two steps: (i) delineation of the set of efficient portfolios, and (ii) selection of the optimal portfolio from the set of efficient portfolios.
- A portfolio is efficient if and only if there is no alternative with (i) the same $\overline{R}_p$ and a lower σ_p, or (ii) the same σ_p and a higher $\overline{R}_p$, or (iii) a higher $\overline{R}_p$ and a lower σ_p. The efficient frontier contains all the efficient portfolios.
- All the points lying on a given risk-return indifference curve offer the same level of satisfaction.

- Given the efficient frontier and the risk-return indifference curves, the optimal portfolio is found at the point of tangency between the efficient frontier and a utility indifference curve.
- In applying the concepts of portfolio theory to capital budgeting, certain differences between securities and capital projects must be borne in mind. In particular two differences are important: (i) Capital projects, unlike securities, are usually not divisible. (ii) Capital projects are assessed in terms of net present value whereas financial securities are assessed in terms of rate of return.
- The expected *NPV* of a portfolio of *m* capital projects is:

$$\overline{NPV}_p = \overline{NPV}_1 + \overline{NPV}_2 + \ldots + \overline{NPV}_m$$

- The standard deviation of the net present value of a portfolio of *m* project is:

$$\sigma_p = \left[\sum_{i=1}^{m} \sigma_i^2 + 2\sum_{i=1}^{m} \sum_{j=i+1}^{m} \sigma_{ij}\right]^{1/2}$$

- The capital asset pricing model, an exercise in positive economics, is concerned with two sets of questions:

I (a) What is the appropriate measure of risk for an efficient portfolio?
(b) What is the relationship between risk and return for efficient portfolios?
II (a) What is the appropriate measure of risk for an individual security or an inefficient portfolio?
(b) What is the relationship between risk and return for an individual security or an inefficient portfolio?

- The relationship between risk and expected return for efficient portfolios, as given by the capital market line, is:

$$\underbrace{\overline{R}_j}_{\text{Expected return}} = \underbrace{r}_{\text{Risk-free rate}} + \underbrace{\lambda}_{\text{Price per unit of risk}} \underbrace{\sigma_j}_{\text{Risk}}$$

- The relationship between risk and return for an inefficient portfolio or a single security is expressed by the security market line:

$$\underbrace{\overline{R}_i}_{\text{Expected return}} = \underbrace{r}_{\text{Risk-free rate}} + \underbrace{(\overline{R}_M - r)}_{\text{Market risk premium}} \underbrace{\frac{C_{iM}}{\sigma_M^2}}_{\text{Risk}}$$

- The risk-free rate is the return on a security that is free from default risk and is uncorrelated with returns from anything else in the economy.
- The market risk premium is the difference between the expected return on the market portfolio and the risk-free rate.
- The beta of a security *j* is the slope of the following regression relationship:

$$R_{jt} = \alpha_j + \beta_j \; R_{mt} + e_{jt}$$

- The relationship between equity beta and asset beta is as follows:

$$\beta_E = \beta_A \left[1 + \frac{D}{E}\right]$$

- The procedure for calculating a project's required rate of return, as per the capital asset pricing model, involves the following steps: (i) Find a sample of firms engaged in the same line of business. (ii) Obtain equity betas for the sample firms. (iii) Derive asset betas after adjusting equity betas for financial leverage. (iv) Find the average of asset betas. (v) Figure out the equity beta for the proposed project. (vi) Estimate the cost of equity for the proposed project. (vii) Calculate the project's required rate of return.

QUESTIONS

1. How is the risk of a 2-security portfolio defined?
2. How is the risk of an n-security portfolio defined?
3. What is the efficient frontier?
4. How is the optimal portfolio on the efficient frontier determined?
5. In applying the concepts of portfolio theory to capital budgeting, what are the differences between securities and capital projects that should be borne in mind?
6. How is the risk of a portfolio of capital projects defined?
7. Mention the assumptions underlying the standard capital asset pricing model.
8. What is the relationship between risk and return for efficient portfolios?
9. Discuss the relationship embodied in the security market line.
10. Show how the security market line is derived.
11. What is the risk-free rate? How would you measure it?
12. Suggest an appropriate measure for the market risk premium and justify it.
13. What is beta and how is it measured?
14. What are fundamental betas? How are they superior to historical (market-generated) betas?
15. Discuss the relationship between equity beta and asset beta in a taxless world?
16. What is the relationship between equity beta and asset beta when taxes exist?
17. Describe the procedure for calculating a project's required rate of return as per the capital asset pricing model.

PROBLEMS

1. A portfolio consists of 5 securities, 1, 2, 3, 4 and 5. The proportions of these securities are: $X_1 = 0.1$, $X_2 = 0.2$, $X_3 = 0.3$, $X_4 = 0.3$, $X_5 = 0.1$. The standard deviations of returns on these securities are $\sigma_1 = 8$, $\sigma_2 = 9$, $\sigma_3 = 10$, $\sigma_4 = 16$, $\sigma_5 = 12$. The correlation coefficients among returns are: $\rho_{12} = 0.1$, $\rho_{13} = 0.5$, $\rho_{14} = -0.2$, $\rho_{15} = 0.3$, $\rho_{23} = 0.4$, $\rho_{24} = 0.8$, $\rho_{25} = 0.2$, $\rho_{34} = 0.1$, $\rho_{35} = 0.6$, $\rho_{45} = 0.1$

   Calculate the standard deviation of the net present value of the portfolio.
2. Assume that a group of securities has the following characteristics: (a) the standard deviation of each security is equal to σ_A; (b) covariance of returns σ_{AB} is equal for each security pair in the group. Calculate the portfolio variance for two portfolios:

(i) a portfolio containing three securities which are equally weighted; and

(ii) a portfolio containing nine securities which are equally weighted.

3. Anamika Enterprises has a portfolio of three projects 1, 2 and 3. The standard deviations of net present values of these projects are: $\sigma_3 = 8000$, $\sigma_2 = 12{,}000$ and $\sigma_1 = 15{,}000$. The matrix of correlation coefficient among these projects is given below:

$$\begin{array}{cccc} & 1 & 2 & 3 \\ 1 & \rho_{11} = 1.0 & \rho_{12} = 0.6 & \rho_{13} = 0.7 \\ 2 & & \rho_{22} = 1.0 & \rho_{23} = 0.2 \\ 3 & & & \rho_{33} = 1.0 \end{array}$$

Calculate the standard deviation of the net present value of the portfolio of the three projects.

4. The existing investments of a firm are projects 1 and 2 with the following characteristics: $\sigma_1 = 15{,}000$, $\sigma_2 = 20{,}000$, and $\rho_{12} = 0.6$. The firm is considering three new projects labelled 3, 4 and 5 respectively. The standard deviations of the net present value of these investments are: $\sigma_3 = 6{,}000$, $\sigma_4 = 9{,}000$, $\sigma_5 = 16{,}000$.

The coefficient of correlation between the net present values of these proposed investments and the existing investments are as follows:

$$\begin{array}{ccc} & 1 & 2 \\ 3 & \rho_{31} = 0.4 & \rho_{32} = 0.7 \\ 4 & \rho_{41} = 0.6 & \rho_{42} = 0.2 \\ 5 & \rho_{51} = 0.3 & \rho_{52} = 0.1 \end{array}$$

Determine the standard deviation of the net present value of various possible portfolios.

5. The one period rates of return on stock B and the market portfolio for a 20 year period are given below:

Period	Return on stock B (%)	Return on market portfolio (%)	Period	Return on stock B (%)	Return on market portfolio (%)
1	15	9	11	– 2	12
2	16	12	12	12	14
3	10	6	13	15	– 6
4	– 15	4	14	12	2
5	– 5	16	15	10	8
6	14	11	16	9	7
7	10	10	17	12	9
8	15	12	18	9	10
9	12	9	19	6	12
10	– 4	8	20	13	10

What is the beta for stock B?

6. An all-equity firm is evaluating the following projects:

Project	Beta	Expected return (%)
A	0.5	15
B	0.8	16
C	1.2	21
D	1.6	22
E	1.7	23

The risk-free rate is 11 per cent, and the expected market premium is 6 per cent. The firm's cost of capital is 16 per cent.

a. Which projects should be accepted?

b. If the firm's cost of capital is used as a hurdle rate, which projects will be accepted or rejected incorrectly?

7. Magnum Limited is considering a cement project for which it proposes to employ a debt-equity ratio of 2:1. Its pre-tax cost of debt will be 16 per cent and its expected tax rate is 30 per cent.

There are three firms, *A*, *B*, and *C* engaged wholly in cement manufacture. Their equity betas and debt-equity ratios are as follows:

	Equity beta	Debt-equity ratio
A	1.25	2.25
B	1.15	2.00
C	1.10	2.10

The risk-free rate is 12 per cent and the expected return on the market portfolio is 17 per cent. What should the required rate of return on Magnum's cement project?

8. Pariman Company's equity beta is 1.25. Its debt-equity ratio is 1.60 and its tax rate is 40 per cent. What is Pariman Company's asset beta?

9. Growmore Fertiliser Company has a debt-to-equity ratio of 1.25 to 1.0. Its cost of debt funds is 12 per cent and it has a marginal tax rate of 40 per cent. Growmore is considering a proposal to diversify into petrochemicals, a field that is considerably different from its own. Growmore regards Sunrise Petrochemicals as a good proxy company. Sunrise has a debt-equity ratio of 1.5, a beta of 1.30, and an effective tax rate of 40 per cent.

(a) If Growmore wishes to manufacture petrochemicals, what systematic risk is involved if it intends employing the same amount of leverage in the new project as it currently employs?

(b) If the risk-free rate is 12 per cent and the expected return on the market portfolio is 18 per cent, what is the required rate of return for the petrochemicals project as per the capital asset pricing model?

14

Social Cost Benefit Analysis

Social Cost Benefit Analysis (SCBA, hereafter), also referred to as economic analysis, is a methodology developed for evaluating investment projects from the point of view of the society (or economy) as a whole. Used primarily for evaluating public investments (though it can be applied to both private and public investments), SCBA has received increasing emphasis in recent years in view of the growing importance of public investments in many countries, particularly in developing countries, where governments are playing a significant role in economic development. SCBA is also relevant, to a certain extent, to private investments as these have now to be approved by various governmental and quasi-governmental agencies which bring to bear larger national considerations in their decisions.

In the context of planned economies, SCBA aids in evaluating individual projects within the planning framework which spells out national economic objectives and broad allocation of resources to various sectors. In other words, SCBA is concerned with tactical decision making within the framework of broad strategic choices defined by planning at the macro level. The perspectives and parameters provided by the macro level plans serve as the basis of SCBA which is a tool for analysing and appraising individual projects.

This chapter, concerned with SCBA, discusses the following :

- Rationale for SCBA
- UNIDO approach to SCBA
- L-M approach to SCBA
- SCBA by financial institutions
- Public sector investment decision making in India

RATIONALE FOR SCBA

In SCBA the focus is on the social costs and benefits of the project. These often tend to differ from the monetary costs and benefits of the project. The principal sources of discrepancy are:

- Market imperfections
- Externalities
- Taxes
- Concern for saving

- Concern for redistribution
- Merit wants

Market Imperfections

Market prices, which form the basis for computing the monetary costs and benefits from the point of view of project sponsor, reflect social values only under conditions of perfect competition, which are rarely, if ever, realised by developing countries. When imperfections are obtained, market prices do not reflect social values.

The common market imperfections found in developing countries are: (i) rationing, (ii) prescription of minimum wage rates, and (iii) foreign exchange regulation. Rationing of a commodity means control over its price and distribution. The price paid by a consumer under rationing is often significantly less than the price that would prevail in a competitive market. When minimum wage rates are prescribed, the wages paid to labour are usually more than what the wages would be in a competitive labour market free from such wage legislations. The official rate of foreign exchange in most of the developing countries, which exercise close regulation over foreign exchange, is typically less than the rate that would prevail in the absence of foreign regulation. This is why foreign exchange usually commands premium in unofficial transactions.

Externalities

A project may have beneficial external effects. For example, it may create certain infrastructural facilities like roads which benefit the neighbouring areas. Such benefits are considered in SCBA, though they are ignored in assessing the monetary benefits to the project sponsors because they do not receive any monetary compensation from those who enjoy this external benefit created by the project. Likewise, a project may have a harmful external effect like environmental pollution. In SCBA, the cost of such environmental pollution is relevant, though the project sponsors may not incur any monetary costs. It may be emphasised that externalities are relevant in SCBA because in such analysis all costs and benefits, irrespective to whom they accrue and whether they are paid for or not, are relevant.

Taxes and Subsidies

From the private point of view, taxes are definite monetary costs and subsidies are definite monetary gains. From the social point of view, however, taxes and subsidies are generally regarded as transfer payments and hence considered irrelevant.

Concern for Savings

Unconcerned about how its benefits are divided between consumption and savings, a private firm does not put differential valuation on savings and consumption. From a social point of view, however, the division of benefits between consumption and savings (which leads to investment) is relevant, particularly in capital-scarce developing countries. A rupee of benefits saved is deemed more valuable than a rupee of benefits consumed. The concern of society for savings and investment is duly reflected in SCBA wherein a higher valuation is placed on savings and a lower valuation is put on consumption.

Concern for Redistribution

A private firm does not bother how its benefits are distributed across various groups in the society. The society, however, is concerned about the distribution of benefits across different groups. A rupee of benefit going to a poor section is considered more valuable than a rupee of benefit going to an affluent section.

Merit Wants

Goals and preferences not expressed in the market place, but believed by policy makers to be in the larger interest, may be referred to as merit wants. For example, the government may prefer to promote an adult education programme or a balanced nutrition programme for school-going children even though these are not sought by consumers in the market place. While merit wants are not relevant from the private point of view, they are important from the social point of view.

UNIDO APPROACH

Towards the end of the sixties and in the early seventies two principal approaches for SCBA emerged: the UNIDO approach and the Little-Mirrlees approach. This section discusses the UNIDO approach; the following discusses the Little-Mirrlees approach.

The UNIDO approach was first articulated in the *Guidelines for Project Evaluation*[1] which provides a comprehensive framework for SCBA in developing countries. The rigour and length of this work created a demand for a succinct and operational guide for project evaluation in practice. To fulfill this need, UNIDO came out with another publication, *Guide to Practical Project Appraisal*[2] in 1978. Our discussion of the UNIDO approach is based largely on the latter publication though at places we will draw on the former publication (generally referred to as *Guidelines*) too.

The UNIDO method of project appraisal involves five stages:

1. Calculation of financial profitability of the project measured at market prices.
2. Obtaining the net benefit of project measured in terms of economic (efficiency) prices.
3. Adjustment for the impact of the project on savings and investment.
4. Adjustment for the impact of the project on income distribution.
5. Adjustment for the impact of project on merit goods and demerit goods whose social values differ from their economic values.

Each stage of appraisal measures the desirability of the project from a different angle.

The measurement of financial profitability of the project in the first stage is similar to the financial evaluation discussed at great length in the previous chapters of this book. So, skipping the first stage, we will discuss the remaining stages here.

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[1] UNIDO, *Guidelines for Project Evaluation*, United Nations, 1972.
[2] UNIDO, *Guide to Practical Project Appraisal*, United Nations, 1978.

NET BENEFIT IN TERMS OF ECONOMIC (EFFICIENCY) PRICES

Stage two of the UNIDO approach is concerned with the determination of the net benefit of the project in terms of economic (efficiency) prices, also referred to as shadow prices.

Market prices represent shadow prices only under conditions of perfect markets which are almost invariably not fulfilled in developing countries. Hence, there is a need for developing shadow prices and measuring net economic benefit in terms of these prices.

Shadow Pricing: Basic Issues

Before we deal with shadow pricing of specific resources, certain basic concepts and issues must be discussed: choice of nume'raire, concept of tradability, source of shadow prices, treatment of taxes, and consumer willingness to pay.

Choice of Nume'raire One of the important aspects of shadow pricing is the determination of the nume'raire, the unit of account in which the value of inputs or outputs is expressed.

To define the nume'raire, the following questions have to be answered: What unit of currency, domestic or foreign, should be used to express benefits and costs? Should costs and benefits be measured in current values or constant values? With reference to which point —present or future—should costs and benefits be evaluated? What use—consumption or investment—will be made of the income from the project ? Should the income of the project be measured in terms of consumption or investment? With reference to which group should the income of the project be measured?

The specifications of the UNIDO nume'raire in terms of the above question is : "net present consumption in the hands of people at the base level of consumption in the private sector in terms of constant price in domestic accounting rupees".

Concept of Tradability A key issue in shadow pricing is whether a good is tradeable or not. For a good that is tradeable, the international price is a measure of its opportunity cost to the country. Why? For a tradeable good, it is possible to substitute import for domestic production and vice versa; similarly it is possible to substitute export for domestic consumption and vice versa. Hence the international price, also referred to as the border price, represents the 'real' value of the good in terms of economic efficiency.

Sources of Shadow Prices The UNIDO approach suggests three sources of shadow pricing, depending on the impact of the project on national economy. A project, as it uses and produces resources, may for any given input or output (i) increase or decrease the total consumption in the economy, (ii) decrease or increase production in the economy, (iii) decrease imports or increase imports, or (iv) increase exports or decrease exports.

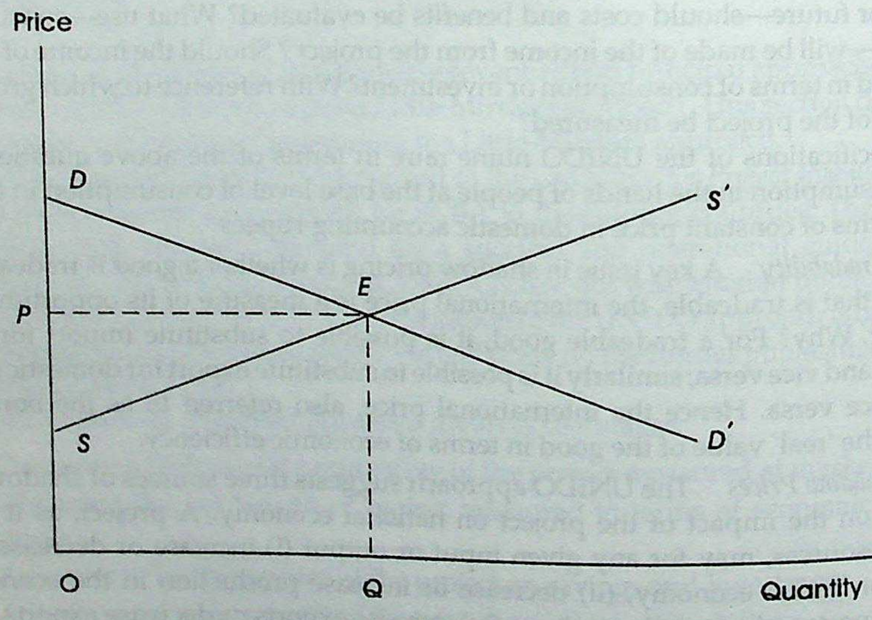
If the impact of the project is on consumption in the economy the basis of shadow pricing is consumer willingness to pay. If the impact of the project is on production in the economy, the basis of shadow pricing is the cost of production. If the impact of project is on international trade—increase in exports, decrease in imports, increase in imports, or decrease in exports—the basis of shadow pricing is the foreign exchange value.

Taxes When shadow prices are being calculated, taxes usually pose difficulties. The general guidelines in the UNIDO approach with respect to taxes are as follows: (i) When a project results in diversion of non-traded inputs which are in fixed supply from other producers or addition to non-traded consumer goods, taxes should be included. (ii) When a project augments domestic production by other producers, taxes should be excluded. (iii) For fully traded goods, taxes should be ignored.

Consumer Willingness to Pay As noted above, if the impact of the project is on consumption in the economy, the basis of shadow pricing is consumer willingness to pay. How is this measured? The measurement of consumer willingness to pay may be explained with the help of Exhibit 14.1. In the graph shown in this exhibit, *DD′* represents the demand schedule, *SS′* the supply schedule, *E* the equilibrium point, *OQ* the quantity bought, and *OP* the price per unit. Looking at the demand schedule we find that the consumer who buys the first unit is willing to pay *OD* for that unit and the consumer who buys the last unit is willing to pay *OP* for that unit. The consumer willingness to pay for various units is indicated by the schedule *DE*. So the total willingness to pay by consumers who buy the product is measured by the area *ODEQ*. The price paid by them, however, is only *OPEQ*. The difference between *ODEQ* and *OPEQ*, namely *DEP*, is referred to as the consumer surplus.

EXHIBIT 14.1

Consumer Willingness to Pay



Shadow Pricing of Specific Resources

Tradeable Inputs and Outputs A good is fully traded when an increase in its consumption results in a corresponding increase in import or decrease in export or when an increase in its production results in a corresponding increase in export or decrease in import. For fully traded goods, the shadow price is the border price, translated in domestic currency at the market exchange rate.

The above definition of a fully traded good implies that domestic changes in demand or supply affect just the level of imports or exports. This means for an imported good, the following conditions should be met: (i) If there is an import quota, it is not restrictive. (ii) The import supply is perfectly elastic over the relevant range of import volume. (iii) There is no surplus capacity in the domestic industry; all additional supply must be imported. If there is surplus domestic capacity it cannot be utilised for want of necessary inputs. (iv) If the additional demand exists inland, the imported goods, even after taking into account the cost of transport from the port of entry to the point of inland demand, cost less than the marginal cost of local production. (v) The imported input costs less than the domestic marginal cost of purchase.

When the above conditions are satisfied, additional demand will be met fully by external trade. Hence the input is considered fully traded. Similar conditions must be satisfied for importable outputs, exportable inputs, and exportable outputs, if they are to be considered fully traded. In practice, it is reasonable to regard tradeable inputs and outputs as fully traded, even if the above mentioned conditions are not fully satisfied.

A good is not traded if it is tradeable but conditions (i) through (iv) above are not fulfilled. For non-traded goods the border price does not reflect its economic value. What then is the value of a non-traded goods? The value of a non-traded good should be measured in terms of what domestic consumers are willing to pay, if the output of the project adds to its domestic supplies or if the requirement of the project causes reductions of its consumption by others. The value of a non-traded good should be measured in terms of its marginal cost of production if the requirement of the project induces additional production or if the output of the project causes reduction of production by other units.

Non-tradeable Inputs and Outputs A good is non-tradeable when the following conditions are satisfied: (i) its import price (CIF price) is greater than its domestic cost of production and (ii) its export price (FOB price) is less than its domestic cost of production.

The valuation of non-tradeables is done as per the principles of shadow pricing discussed earlier. On the output side, if the impact of the project is to increase the consumption of the product in the economy, the measure of value is the marginal consumers' willingness to pay; if the impact of the project is to substitute other production of the same non-tradeable in the economy, the measure of value is the saving in cost of production. On the input side, if the impact of the project is to reduce the availability of the input to other users, their willingness to pay for that input represents social value; if the project's input requirement is met by additional production of it, the production cost of it is the measure of social value.

Externalities An externality, also referred to as an external effect, is a special class of good which has the following characteristics: (i) It is not deliberately created by the project sponsor but is an incidental outcome of legitimate economic activity. (ii) It is beyond the control of the persons who are affected by it, for better or for worse. (iii) It is not traded in the market place.

An external effect may be beneficial or harmful. Examples of beneficial external effects are:

- An oil company drilling in its own fields may generate useful information about oil potential in the neighbouring fields.
- The approach roads built by a company may improve the transport system in that area.
- The training programme of a firm may upgrade the skills of its workers thereby enhancing their earning power in subsequent employments.

Examples of harmful external effects are:

- A factory may cause environmental pollution by emitting large volumes of smoke and dirt. People living in the neighbourhood may be exposed to health hazards and put to inconvenience.
- The location of an airport in a certain area may raise noise level considerably in the neighbourhood.
- A highway may cut a farmer's holding in two, separating his grazing land and his cowsheds, thereby adversely affecting his physical output.

Since SCBA seeks to consider all costs and benefits, to whomsoever they may accrue, external effects need to be taken into account. The valuation of external effects is rather difficult because they are often intangible in nature and there is no market price which can be used as a starting point. Their value is estimated by indirect means. For example:

- The benefit of information provided by the oil field to neighbouring oil fields may be equated with what the neighbouring oil fields would have spent to obtain such information.
- The value of better transport provided by the approach roads may be estimated in terms of increased activities and benefits derived therefrom.
- The benefit from the training programme may be estimated in terms of the increased earning power of workers.
- The cost of pollution may be estimated in terms of the loss of earnings as a result of damage to health caused by it and the cost of time spent for coping with unhygienic surroundings.
- The cost of noise may be inferred from the differences in rent between the noise-affected area and that of some other area which is comparable except for the level of noise.
- The harmful external effect of the highway may be measured by the consumer willingness to pay for the output of farmer which has been reduced due to the highway.

The above examples serve to emphasise the difficulties in measuring external effects. In view of this, some economists have suggested that these effects be ignored. In order to justify their suggestion, they argue that since a project is likely to have both beneficial and harmful external effects, one may not err much in assuming that the net effect would be zero. This argument, seemingly a rationalisation for one's ignorance, lacks validity. External effects must be taken into account wherever it is possible to do so. Even if these effects cannot be measured in monetary terms, some qualitative evaluation must be attempted.

Labour Inputs The principles of shadow pricing for goods may be applied to labour as well, though labour is considered to be service. When a project hires labour, it could have three possible impacts on the rest of the economy: it may take labour away from other employments; it may induce the production of new workers; and it may involve import of workers.

When a project takes labour away from other employments, the shadow price of labour is equal to what other users of labour are willing to pay for this labour. In a relatively free market this will be equal to the marginal product of such labour.

The social cost associated with inducing 'additional' production of workers consists of the following: (i) the marginal product of the worker in the previous employment—if the worker is previously unemployed, this would naturally be zero; (ii) the value assigned by the worker on the leisure that he may have to forego as a result of employment in the project —the value of this leisure is reflected in his reservation wage[3]; (iii) the additional consumption of food when a worker is fully employed as opposed to when he is idle or only partly employed; (iv) the cost of transport and rehabilitation when a worker is moved from one location to another; (v) the increased consumption by the worker and its negative impact on savings and investment in the society when the worker is paid market wage rate by the project; and (i) the cost of training a worker to improve his skills.

The social cost associated with import of foreign workers is the wage they command. In their case, however, a premium should be added on account of foreign exchange remitted abroad by these workers from their savings.

Capital Inputs When a capital investment is made in a project two things happen: (i) Financial resources are converted into physical assets. (ii) Financial resources are withdrawn from the national pool of savings and hence alternative projects are foregone. Thus, shadow pricing of capital investment involves two questions:

- What is the value of physical assets?
- What is the opportunity cost of capital (which reflects the benefit foregone by sacrificing alternative project/s)?

The value (shadow price) of physical assets is calculated the way the value of other resources is calculated. If it is a fully traded good, its shadow price is equal to its border price. If it is a non-traded good its price is measured in terms of cost of production (if the project induces additional domestic production of the asset) or consumer willingness to pay (if the project takes the asset from other users).

The opportunity cost of capital depends on how the capital required for the project is generated. To the extent that it comes from additional savings, its opportunity cost is measured by the consumption rate of interest (which reflects the price the saver must be paid to sacrifice present consumption); to the extent that it comes from the denial of capital to alternative projects, its opportunity cost is the rate of return that would be earned from those alternative projects. This is also called the investment rate of interest. In practice, the consumption rate of interest may be used as the discount rate because in stage three of UNIDO analysis all inputs and outputs are converted into their consumption equivalents.

There are, however, problems in determining the consumption rate of interest empirically. So the UNIDO approach recommends a 'bottom up' procedure. As per this procedure, the project analyst calculates the internal rate of return of a project and presents the project to the planners (or politicians) who are the decision makers. If the project is accepted, the analyst may assume that the planners judge the consumption rate of interest to be more than the interest rate of return. On the basis of a repetitive application of this process, the range for estimated consumption rate of interest can be sufficiently narrowed for practical use, provided, of course, the planners on the top are consistent.

Foreign Exchange The UNIDO method uses domestic currency as the nume'raire. So the foreign exchange input of the project must be identified and adjusted by an appropriate premium. This means that valuation of inputs and outputs that were measured in border rupees has to be adjusted upward to reflect the shadow price of foreign exchange.

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[3] The reservation wage of a person depends on the following:
(i) the income he already enjoys through transfer payments, (ii) his idea of what job is acceptable to him, and (iii) his preference for work and leisure.

How is the shadow price of foreign exchange established? The *Guidelines* method determines the shadow price of foreign exchange on the basis of marginal social value as revealed by the consumer willingness to pay for the goods that are allowed to be imported at the margin. The shadow price of a unit of foreign exchange is equal to:

$$\sum_{i=1}^{n} F_i Q_i P_i \tag{14.1}$$

where F_i = fraction of foreign exchange, at the margin, spent on importing commodity i

Q_i = quantity of commodity i that can be bought with one unit foreign exchange (This will be equal to 1 divided by the CIF value of the good in question.)

P_i = domestic market clearing price of commodity i

Example Commodities 1, 2, 3, and 4 are imported at the margin. The proportion of foreign exchange spent on them, the quantities that can be bought per unit of foreign exchange, and the domestic market clearing prices are as follows:

$F_1 = 0.3,$ $F_2 = 0.4,$ $F_3 = 0.2,$ $F_4 = 0.1$
$Q_1 = 0.6,$ $Q_2 = 1.5,$ $Q_3 = 0.25,$ $Q_4 = 3.0$
$P_1 = 16,$ $P_2 = 8,$ $P_3 = 40,$ $P_4 = 5$

The value of a unit of foreign exchange is:

$$(.3)(0.6)(16) + (0.4)(1.5)(8) + (0.2)(0.25)(40) + (.1)(3.0)(5) = \text{Rs. } 13.180.$$

The calculation of the shadow price of foreign exchange in terms of consumer willingness to pay is based on the assumption that the foreign exchange requirement of a project is met from the sacrifice of others. The use of foreign exchange by a project, however, may also induce the production of foreign exchange through additional exports or import substitution. In such a case, the shadow price of foreign exchange would be based on the cost of producing foreign exchange, not consumer willingness to pay for foreign exchange. One of the best known approaches to determine the cost of producing foreign exchange is the domestic resource cost method proposed by Michael Bruno. Though this approach is oriented to estimate what is the cost of producing foreign exchange by a single project, its principles can be applied to estimate the cost of producing foreign exchange at the macro level.

Programming Approach Another approach for determining the value of foreign exchange is the programming approach. According to this approach the shadow price of foreign exchange is obtained by solving the dual problem of an economy-wide optimising mathematical programming model. In the primal model, one of the constraints represents limited foreign exchange availability. (More than one constraint relating to foreign exchange may be introduced if it is necessary to distinguish various foreign currencies.) Hence the shadow price represents the contribution that unit of foreign exchange at the margin would make to the objective function.

Conceptually sound, the usefulness of this approach in practice depends on whether the model reflects economic realities and whether the required data are available. Since these conditions are not readily satisfied, caution should be exercised in employing this approach.

Bridge Project

To illustrate the calculation of net economic benefit, two examples are given. The first example is that of a bridge project. The second example is that of a river valley project.

Presently, a ferry service, operated privately, is being used to cross a river. The ferry operator charges Rs 3 per person. It costs him Rs 2 per person. 50,000 persons use the ferry service. (This means that the number of persons crossing the river by ferry service throughout the year is 50,000.)

The government is considering construction of a bridge over the river. It is estimated that after the bridge is constructed 2,50,000 persons will cross the river on the bridge. The bridge is expected to cost Rs 3 million initially and its annual maintenance cost would be Rs 10,000. It has an indefinitely long life. Once the bridge is constructed the ferry operator is expected to close down the ferry service and sell the ferry boats for Rs 100,000.

Required: Define the social costs and benefits of constructing the bridge, assuming that the monetary figures given in the problem represent economic values .

Solution: The social costs and benefits of bridge construction may be defined as follows:

Costs

These consists of the following:

1. Construction cost : Rs 3,000,000 (This is a one-shot cost.)
2. Maintenance cost : Rs 10,000 (This is an annual cost.)

Benefits

These consist of the following:

1. Value of ferries released : Rs 100,000 (This is a one-shot benefit.)
2. Savings in the cost of ferry operation: Rs 100,000 (This is an annual benefit.)
3. Increase in consumer satisfaction: This is equal to willingness to pay of 200,000 additional persons who are expected to use the bridge. Since the first additional person is willing to pay almost Rs 3 (the charge of the ferry operator) and the last person is willing to pay almost nothing (there is no toll for using the bridge) the average willingness to pay of additional users, assuming that the demand schedule is linear, is Rs 1.50. So the willingness to pay of 200,000 additional persons is 200,000 × Rs.1.50 = Rs 300,000. (This is shown in Exhibit 14.2 by the triangle.)

River Valley Project

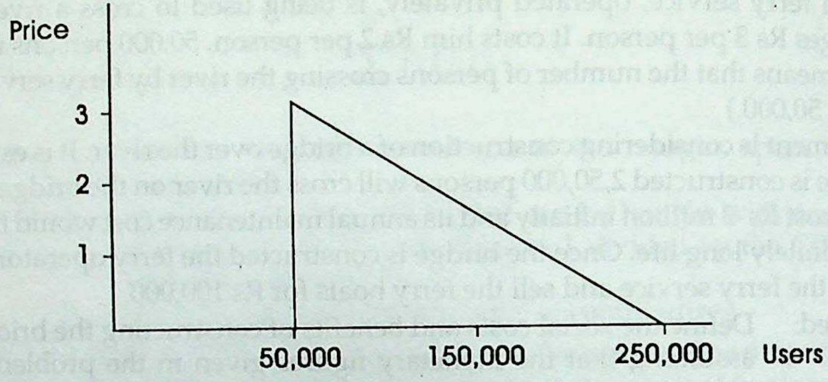
The government is considering a multi-purpose river valley project which would involve construction of a dam, a reservoir, a power house, and several irrigation canals. The project would supply water for irrigation, generate electricity, and provide a measure of protection against floods. The following information has been gathered by the project control board.

The project will require the following during the construction stage:

1. Indigenous power equipment costing Rs 200 million.
2. Imported power equipment costing $ 10 million.
3. 20,000 tonnes of steel produced indigenously and made available to the project at Rs 6000 a tonne.

EXHIBIT 14.2

Consumer Willingness to Pay



4. 350,000 tonnes of cement produced indigenously and made available to the project at Rs 800 a tonne.
5. Other construction materials (sand, bricks, etc.) costing Rs 100 million.
6. 25 million mandays of unskilled labour for which the project control board has decided to pay a daily wage rate of Rs 10.
7. Skilled labour costing Rs 100 million.

Once commissioned, the operating and maintenance cost of the project would be Rs 35 million per year.

The annual benefits expected from the project would be as follows:

1. 300,000 acres of land will be irrigated.
2. 120 million units of electricity will be generated for domestic use.
3. Flood damages to the extent of Rs 10 million will be saved annually.

The following additional information is available:

1. Power equipment produced indigenously is a tradeable item whose FOB value is $ 15 million.
2. A gift of $ 10 million, available from a foreign agency, can be used for acquiring imported equipment. This gift, however, is not project-tied. Hence, if it is not assigned to the project, it can be used for some other purpose.
3. The shadow price per dollar is Rs 12, though the official price is Rs 10.
4. Steel is a tradeable item whose FOB value is $400 per tonne.
5. Cement is not a tradeable item. One-half of the cement required for the project will come from additional domestic production which has a cost of Rs 700 per tonne; one-half of the cement required for the project will come from diversion from other consumers who are willing to pay, on average, Rs 1,200 per tonne.
6. Other construction materials are non-tradeable items. The requirement of the project will be met by way of additional production. The cost of this production will be Rs 80 million.
7. The shadow price of unskilled labour is Rs 5 per day.

8. The compensation paid to skilled labour reflects what others are willing to pay for their services.
9. The operating and maintenance cost of Rs 35 million reflects economic value as well.
10. The water levy by the project control board would be Rs 100 per acre. However, the value of additional output per acre, attributable to the water supplied by the project, will be Rs 400 a year.
11. The electricity tariff charged by the project control board would be 30 paise per unit. The consumer willingness to pay, however, would be, on an average, 50 per cent more than the tariff charged.
12. The project control board is not able to collect anything for the protection provided against floods.

Required: Define the costs and benefits from the private (project control board's) and the economic point of view.

Solution: The costs and benefits from the private and economic (social) angles are shown in Exhibit 14.3.

EXHIBIT 14.3

Costs and Benefits from the Private and Economic Angles

	Nature	Private angle (Rs in million)	Economic angle (Rs in million)	Explanation for economic values
Costs				
1. Indigenous power equipment	One shot	200	180	This is a tradeable item whose FOB value is $15 million. This is converted into rupees by applying the shadow price of foreign exchange.
2. Imported power equipment	One shot	–	120	The foreign exchange is converted into rupees by applying the shadow price of foreign exchange.
3. Steel	One shot	120	96	This is a tradeable item whose FOB value is $8 million. This is converted into rupees by applying the shadow price of foreign exchange.
4. Cement	One shot	280	332.5	This is a non-tradeable item. 175,000 tonnes of cement required by the project is produced additionally in the country for which the cost of production is Rs 122.5 million. 1,75,000 tonnes of cement required for the project is diverted from other users who are willing to pay Rs 210 million.

(Continued)

Exhibit 14.3 (Continued)

	Nature	Private angle (Rs in million)	Economic angle (Rs in million)	Explanation for economic values
5. Other construction material	One shot	100	80	This is a non-tradeable item. The requirement of the project is met by additional domestic production costing Rs 80 million.
6. Unskilled labour	One shot	250	125	25 million mandays are multiplied by Rs 5, the shadow wage rate.
7. Skilled labour	One shot	100	100	The compensation paid to skilled labour reflects what others are willing to pay for it.
8. Operating and maintenance cost	Annual	35	35	The annual operating and maintenance cost reflects economic value as well.
Benefits				
1. Irrigation	Annual	30	120	The value of additional agricultural output attributable to the water supplied by the project is Rs 120 million.
2. Electricity	Annual	36	54	The consumer willingness to pay for the electricity provided by the project is, on average, 50 per cent higher than the electricity tariff charged.
3. Flood relief	Annual	–	10	The value of savings due to flood relief benefit from the project is Rs 10 million annually.

MEASUREMENT OF THE IMPACT ON DISTRIBUTION

Stages three and four of the UNIDO method are concerned with measuring the value of a project in terms of its contribution to savings and income redistribution. To facilitate such assessments, we must first measure the income gained or lost by individual groups within the society.

Groups

For income distribution analysis, the society may be divided into various groups. The UNIDO approach seeks to identify income gains and losses by the following:

- Project
- Other private business
- Government
- Workers

- Consumers
- External sector.

There can, however be, other equally valid groupings.

Measure of Gain or Loss

The gain or loss to an individual group within the society as a result of the project is equal to the difference between the shadow price and the market price of each input or output in the case of physical resources or the difference between the price paid and the value received in the case of financial transaction.

Example 1 Farmers in a certain area use 1 million units of electricity generated by a hydro-electric project. The benefit derived by them, measured in terms of the willingness to pay, is equal to Rs 0.4 million. The tariff paid by them to the electricity board is Rs 0.25 million. So, the impact of the project on the farmers is a gain of Rs 0.15 million.

Example 2 A mining project requires 1,000 labourers. These labourers are prepared to offer themselves for work at a daily wage rate of Rs 4. (This represents their supply price.) The wage rate paid to the labourers, however, is Rs 10 per day. So the redistribution benefit enjoyed by the group of 1,000 labourers is Rs 6,000 (1,000 × (10 – 4)) per day.

SAVINGS IMPACT AND ITS VALUE

Most of the developing countries face scarcity of capital. Hence, the governments of these countries are concerned about the impact of a project on savings and its value thereof. Stage three of the UNIDO method, concerned with this, seeks to answer the following questions:

- Given the income distribution impact of the project what would be its effects on savings?
- What is the value of such savings to the society?

Impact on Savings

The savings impact of a project is equal to:

$$\sum \Delta Y_i MPS_i \tag{14.2}$$

where

ΔY_i = change in income of group i as a result of the project.

MPS_i = marginal propensity to save of group i

Example As a result of a project the income gained/lost by four groups is: Group 1 = Rs 100,000, Group 2 = Rs 500,000, Group 3 = – Rs 200,000, and Group 4 = – Rs 400,000. The marginal propensity to save of these four groups is as follows:

$MPS_1 = 0.05$, $MPS_2 = 0.10$, $MPS_3 = 0.20$, and $MPS_4 = 0.40$.

The impact on savings of the project is:

$$100{,}000 \times 0.05 + 500{,}000 \times 0.10 - 2\,00{,}000 \times 0.20 - 400{,}000 \times 0.40 = -\text{Rs } 1\,45{,}000.$$

Value of Savings

The value of a rupee of savings is the present value of the additional consumption stream produced when that rupee of savings is invested at the margin. The additional stream of consumption generated by a rupee of investment depends on the marginal productivity of capital and the rate of reinvestment from additional income. If the marginal productivity of capital is r and the rate of reinvestment from additional income a, the additional stream of consumption generated by a rupee of investment can be worked out as shown in Exhibit 14.4.

EXHIBIT 14.4

Derivation of Additional Consumption Stream from a Rupee of Investment Now

Year	0	1	2	3	... n ...
Investment (cumulative)	1	$1 + ar$	$(1 + ar)^2$		$(1 + ar)^n$
Income		r	$r\,(1 + ar)$	$r\,(1 + ar)^2$	$r\,(1 + ar)^{n-1}$
Additional investment		ar	$ar\,(1 + ar)$	$ar\,(1 + ar)^2$	$ar\,(1 + ar)^{n-1}$
Consumption		$r\,(1 - a)$	$r\,(1 - a)$ $(1 + ar)$	$r\,(1 - a)$ $(1 + ar)^2$	$r\,(1 - a)\,(1 + ar)^{n-1}$

From this exhibit we find that the consumption stream starts with $r\,(1-a)$ and grows annually at the rate of ar forever. Its present value when discounted at the social discount rate k is:

$$I = \frac{r\,(1-a)}{(1+k)} + \frac{r\,(1-a)\,(1+ar)}{(1+k)^2} + \ldots + \frac{r\,(1-a)\,(1+ar)^{n-1}}{(1+k)^n} + \ldots$$

$$= \frac{\dfrac{r\,(1-a)}{(1+k)}}{1 - \dfrac{(1+ar)}{(1+k)}} = \frac{r\,(1-a)}{k - ar} \qquad (14.3)$$

where I = social value of a rupee of savings (investment)
r = marginal productivity of capital
a = reinvestment rate on additional income arising from investment
k = social discount rate.

The social value of savings (also called the shadow price of investment) for certain values of $r, a,$ and k is given in Exhibit 14.5. The formula for the social value of savings is valid when the following conditions are satisfied: (i) The marginal productivity of capital and the reinvestment rate on additional income (marginal propensity to save) are constant over time. (ii) Savings rate in the society will not become optimal in the foreseeable future. While these conditions may seem somewhat restrictive, in practice, for want of better information, it is convenient to accept them.

INCOME DISTRIBUTION IMPACT

Many governments regard redistribution of income in favour of economically weaker sections or economically backward regions as a socially desirable objective. Due to practical difficulties in pursuing the objective of redistribution entirely through the tax, subsidy, and transfer measures of the government, investment projects are also considered as investments for income redistribution and their contribution toward this goal is considered in their evaluation. This calls for suitably weighing the net gain or loss by each group, measured earlier, to reflect the relative value of income for different groups and summing them.

How should the relative weights be determined? The *Guidelines* suggested that the weights, which essentially reflect political judgements, may be determined by an iterative process involving interaction between the analyst and the planners. To illustrate, consider a project:

EXHIBIT 14.5

Shadow Price of Investment

		$k = 0.08$	$k = 0.10$	$k = 0.12$
$r = 0.10$	$a = 0.20$	1.33	1.00	0.80
	$a = 0.30$	1.40	1.00	0.77
	$a = 0.40$	1.50	1.00	0.75
	$a = 0.50$	1.67	1.00	0.71
$r = 0.12$	$a = 0.20$	1.72	1.26	1.00
	$a = 0.30$	1.91	1.31	1.00
	$a = 0.40$	2.25	1.38	1.00
	$a = 0.50$	3.00	1.50	1.00
$r = 0.15$	$a = 0.20$	2.40	1.71	1.33
	$a = 0.30$	3.00	1.91	1.40
	$a = 0.40$	4.50	2.25	1.50
	$a = 0.50$	15.00	3.00	1.67

Net present value of the project	– Rs 2 million
Income gain to low income group as a result of the project	Rs 5 million

Suppose the project is accepted by the planners. This implies that the planners place a premium of at least 40 per cent on income going to the poor. If the planners reject this project but accept some other project which requires a premium of at least 30 per cent on the income going to the poor, the project analyst may infer that the premium placed by planners on income going to the poor lies between 30 per cent and 40 per cent.

This procedure works well if only two groups are involved (in the previous example it was assumed that the two groups were the poor and the others). Where more than two groups are involved the procedure breaks down because several unknown weights are involved. In such a situation, the analyst would not be able to figure out, given the preference of the planners, the relative weights assigned by them on income to the various groups. To tackle this problem, a single factor has to be found which determines the income distribution weights so that the 'bottom-up' approach becomes workable. This single factor, as economists suggest, is the elasticity of marginal utility of income.[4] This is defined as the rate at which the marginal utility of income falls with increases in the level of income. For example, if the marginal utility of income declines by 5 per cent with a 5 per cent increase in income, the elasticity of marginal utility of income is 5 per cent/5 per cent = 1.[5] Likewise, if the marginal utility of income declines by 10 per cent with a 5 per cent increase in income, the elasticity of marginal utility of income is 10 per cent/5 per cent = 2. If the elasticity of marginal utility is equal to 1.0, a 1 per cent increase in the income of a person earning Rs 1,000 a year is socially as valuable as a 1 per cent increase in the income of a person earning Rs 10,000 a year, or Rs 100,000 a year, or for that matter any amount a year. This means that from the social point of view the following gains are equally valuable:

A gain of Rs 10 to a person earning Rs 1,000 a year
A gain of Rs 100 to a person earning Rs 10,000 a year
A gain of Rs 1,000 to a person earning Rs 100,000 a year.

This implies that if the weight at Rs 1,000 is put at 1, the weight at Rs 10,000 is 1/10, and the weight at Rs 100,000 is 1/100.

In general, the weight attached to an income is given by the formula:

$$w_i = \left(\frac{b}{c_i}\right)^n \tag{14.4}$$

where w_i = weight attached to income at c_i level
b = base level of income that has a weight of 1
n = elasticity of the marginal utility of income.

Exhibit 14.6 shows the relative weights for different levels of income for values of n varying between 0 and 1, given a base level of income of Rs 1,000 which has a weight of 1.

EXHIBIT 14.6

Relative Weights for Different Levels of Income for Values of *n* Varying Between 0 and 1

	Value of n				
Level of income	**0.2**	**0.4**	**0.6**	**0.8**	**1.0**
500	1.15	1.32	1.52	1.74	2.00
1,000	1.00	1.00	1.00	1.00	1.00
5,000	0.72	0.53	0.38	0.28	0.20
10,000	0.63	0.40	0.25	0.16	0.10
20,000	0.55	0.30	0.17	0.09	0.05
30,000	0.51	0.26	0.13	0.07	0.03
50,000	0.46	0.21	0.10	0.04	0.02
100,000	0.40	0.16	0.06	0.03	0.01

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[4] The marginal utility of income is the value derived from one more unit of income. This obviously depends on the present level of income.

[5] It may be noted that by convention the negative sign is omitted.

ADJUSTMENT FOR MERIT AND DEMERIT GOODS

In some cases, the analysis has to be extended beyond stage four to reflect the difference between the economic value and social value of resources. This difference exists in the case of merit goods and demerit goods. A merit good is one for which the social value exceeds the economic value. For example, a country may place a higher social value than economic value on production of oil because it reduces dependence on foreign supplies. The concept of merit goods can be extended to include a socially desirable outcome like creation of employment. In the absence of the project, the government perhaps would be willing to pay unemployment compensation or provide mere make-work jobs.

In the case of a demerit good, the social value of the good is less than its economic value. For example, a country may regard alcoholic products as having social value less than economic value.

The procedure for adjusting for the difference between social value and economic value is as follows: (i) Estimate the economic value. (ii) Calculate the adjustment factor as the difference between the ratio of social value to economic value and unity. (iii) Multiply the economic value by the adjustment factor to obtain the adjustment. (iv) Add the adjustment to the net present value of the project as calculated in stage four.

To illustrate, consider a project for which the following information is available : (i) The present economic value of the output of the project is Rs 25 million. (ii) The output of the project has social value which exceeds its economic value by 20 per cent. Given this information, the adjustment factor would be 0.2 (120 per cent/100 per cent –1). Multiplying the present economic value by 0.2, we get an adjustment of Rs 5 million. This, then, is added to the present economic value of Rs 25 million.

Where the socially valuable output of the project does not appear as an output in the economic analysis—as is the case where the project generates employment—the procedure is somewhat different. In such a case the output is treated like an externality and its valuation in social terms is the adjustment.

While the adjustment for the difference between the social value and economic value is seemingly a step in the right direction, it is amenable to abuse. Once the analyst begins to make adjustment for social reasons, projects which are undesirable economically may be made to appear attractive after such adjustment. Since the dividing line between 'political' and 'social' is rather nebulous, it becomes somewhat easy to push politically expedient projects, irrespective of their economic merit by investing them with social desirability. While there is no way to prevent such a manipulation, the stage-by-stage UNIDO approach mitigates its occurrence by throwing it in sharp relief.

LITTLE-MIRRLEES APPROACH

I.M.D. Little and J.A. Mirrlees have developed an approach (hereafter referred to as the L-M approach) to social cost benefit analysis expounded by them in the following works: *Manual of Industrial Project Analysis in Developing Countries, Vol.II* and *Project Appraisal and Planning for Developing Countries*.

There is considerable similarity between the UNIDO approach and the L-M approach. Both the approaches call for:

1. Calculating accounting (shadow) prices particularly for foreign exchange savings and unskilled labour,
2. Considering the factor of equity, and
3. Use of DCF analysis.

Despite considerable similarities there are certain differences between the two approaches:

1. The UNIDO approach measures costs and benefits in terms of domestic rupees whereas the L-M approach measures costs and benefits in terms of international prices, also referred to as border prices.
2. The UNIDO approach measures costs and benefits in terms of consumption whereas the L-M approach measures costs and benefits in terms of uncommitted social income.
3. The stage-by-stage analysis recommended by the UNIDO approach focuses on efficiency, savings, and redistribution considerations in different stages. The L-M approach, however, tends to view these considerations together.

SHADOW PRICES

The outputs and inputs of a project are classified into the following categories: (i) traded goods and services, (ii) non-traded goods and services, and (iii) labour.

Shadow Price of Traded Goods

The shadow price of a traded good is simply its border price. If a good is exported, its shadow price is its FOB price and if a good is imported its shadow price is its CIF price. If foreign demand is not perfectly elastic, the marginal export revenue is substituted for the FOB price; similarly, if foreign supply is not perfectly elastic, the marginal import cost is substituted for the CIF price. The logic for using border prices for traded goods is fairly straight-forward: border prices represent the correct social opportunity costs or benefits of using or producing a traded good.

Accounting Price[6] of Non-Traded Goods

Some goods and services like land, building, transportation, and electricity are not amenable to foreign trade. Hence, there is no border price observable for them. Accounting prices for non-traded items are defined in terms of marginal social cost and marginal social benefit.

The marginal social cost of a good is the value in terms of accounting prices of the resources required to produce an extra unit of the good. For example, the marginal social cost of a bus trip is roughly equal to the cost of material inputs (fuel, oil, wear and tear of the bus, etc.) evaluated at border prices plus the social wage of the driver and the conductor.

The marginal social benefit is the value of an extra unit of the good from the social point of view. When a good is not taxed and consumed by only one income group, its marginal social benefit is equal to its market price multiplied by a factor which represents the value assigned to an increase in the income of that group vis-a-vis an equal increase in uncommitted social income.

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[6] The terms accounting price and shadow price are used inter-changeably.

To determine the accounting price of a non-traded input, one should estimate the proportion in which the demand for that input will be met from increased production and decreased consumption elsewhere in the economy. If the proportion of increase in production to decrease in consumption is, say, 2:1, the accounting price of the non-traded input will be:

$$\frac{2}{3}\text{ Marginal social cost } + \frac{1}{3}\text{ Marginal social benefit}$$

Use of Conversion Factors

Ideally, the accounting price of a non-traded item is defined in terms of marginal social cost and marginal social benefit. In practice, the calculation of marginal social cost and marginal social benefit is often a difficult task. As a practical expedient, L-M suggest that the monetary cost of a non-traded item be broken down into tradeable, labour, and residual components. The tradeable and residual components may be converted into social cost by applying suitable social conversion factors; the labour component's social cost can be obtained by using social wage rate (which is discussed below).

Shadow Wage Rate

The shadow wage rate is an important but difficult-to-determine element in social cost benefit analysis. It is a function of several factors: (i) the marginal productivity of labour, (ii) the cost associated with urbanisation (cost of transport, urban overheads, etc.), and (iii) the cost of having an additional amount committed to consumption when the consumption of worker increases as a result of the higher income he enjoys in urban employment.

L-M suggest the following formula for calculating the shadow wage rate:

$$SWR = c' - \frac{1}{s}(c - m) \tag{14.5}$$

where SWR = shadow wage rate

c' = additional resources devoted to consumption

$1/s$ = value of a unit of committed resource

c = consumption of the wage earner

m = marginal product of the wage earner.

To understand clearly the components of SWR, Eq. (14.5) may be rewritten as follows:

$$SWR = m + (c' - c) + \left(1 - \frac{1}{s}\right)(c - m) \tag{14.6}$$

The first term, m, is the marginal product of labour; the second term, $(c' - c)$, represents the cost of urbanisation (it is the cost associated with providing the consumption level of c though it does not form part of it); the third term, $(1 - 1/s)$ $(c - m)$, represents the cost of having an additional amount $(c - m)$ committed to consumption (it may be noted that 1 is the value of a unit of uncommitted resource and $1/s$ is the value of a unit of committed resource).

Accounting Rate of Return[7]

The accounting rate of return (interest) is the rate used for discounting social profits. In determining the accounting rate of return the following considerations should be borne in mind:

- The future social profit for all the projects must be discounted in the same way.
- The accounting rate(s) of interest should be such that all mutually compatible projects with positive present social value can be undertaken.
- The accounting rate of interest should maintain some kind of balance between investment and investible resources: too low an accounting rate of interest would lead to over-investment with inflationary effects and too high an accounting rate of interest would leave savings under-utilised and result in excessive unemployment.
- The rate of return currently being earned is a good guide to the accounting rate of interest when the following conditions are reasonably satisfied: (i) indirect taxes are fairly uniform with little discrimination between imported and exported commodities, and (ii) the social wage rate is close to the actual wage rate.
- The initial estimate of the accounting rate of interest should, in principle, be such that it would allow only a few of the best projects in the past.
- Experience is the best guide to the choice of accounting rate of interest: if the investment requirement of acceptable projects exceeds the availability of investible funds, increase the accounting rate of interest; if the investment requirement of acceptable projects is less than the availability of investible funds, decrease the accounting rate of interest. The adjustment in the accounting rate of interest, however, should be gradual over time.

SCBA BY FINANCIAL INSTITUTIONS

The all-India term-lending financial institutions—IDBI, IFCI, and ICICI—appraise project proposals primarily from the financial point of view. However, they also scrutinise projects from the larger social point of view. ICICI was perhaps the first financial institution to introduce a system of economic analysis as distinct from financial profitability analysis. IFCI adopted a system of economic appraisal in 1979. Finally, IDBI also introduced a system for economic appraisal of projects financed by them. Though there are some minor variations, the three institutions follow essentially a similar approach which is a simplified version of the L-M approach. We shall describe the appraisal procedure followed by IDBI.

IDBI, in its economic appraisal of industrial projects, considers three aspects:

- Economic rate of return
- Effective rate of protection
- Domestic resource cost

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[7] Note that the accounting rate of return here refers to the social discount rate. It is very different in meaning from the accounting rate of return discussed in Chapter 1.

Economic Rate of Return

The method followed by IDBI to calculate the economic rate of return may be described as a 'partial Little-Mirrlees' method because while international prices are used for valuation of tradeable inputs and outputs, L-M method is not followed in its entirety. The significant elements of IDBI's method are described below:

1. International prices are regarded as the relevant economic prices and, hence, it is necessary to substitute market prices with international prices for all non-labour inputs and outputs.
2. For tradeable items, where international prices are directly available, CIF prices are used for inputs and FOB prices are used for outputs.
3. For tradeable items where international prices are not directly available and for non-tradeable items (like electricity, transportation, etc.) social conversion factors are used to convert actual rupee cost into social cost. In some cases (like land) a social conversion factor is applied directly to the actual rupee cost. In other cases (like transport) the actual rupee cost is broken down into three components—tradeable component, labour component, and residual component—and these components are valued in social terms. Generally, the social cost of the tradeable component is obtained by multiplying it by a factor of 1/1.5; the social cost of labour component is obtained by multiplying it by a factor of 0.5 (shadow price of labour is considered to be 50 per cent of the actual); the social cost of the residual component is obtained by multiplying it by a factor of 0.5. Exhibit 14.7 shows the social conversion factor/break-up into tradeable, labour, and residual components for various items.

EXHIBIT 14.7

Social Conversion Factor (SCF) or Proportions of Three Components, Tradeable (T), Labour (L), and Residual (R)

Item	SCF or Proportions
Land	SCF = 1/1.5
Buildings and construction	Proportions: T = 0.5, L = 0.25, R = 0.25
Indigenous equipment	SCF = 0.70
Transportation	Proportions: T = 0.65, L = 0.25, R = 0.10
Engineering and know-how fees	SCF = 1.50
Bank charges	SCF = 0.02
Preoperative expenses	SCF = 1.00
Labour	SCF = 0.50
Salaries	SCF = 0.80
Repairs and maintenance	SCF = 1/1.5
Water, fuel, etc.	Proportions: T = 0.50, L = 0.25, R = 0.25
Electricity	Proportions: T = 0.71, L = 0.13, R = 0.16
Domestic stores	SCF = 0.80
Other overheads	SCF = 1/1.5

Illustration

A new project for manufacturing a product which is currently being imported in the country is being appraised. The project would have a life of 15 years and it will lead to import substitution. The capital outlay on the project would be as follows:

	(Rs in million)
Land	0.2
Buildings	10.0
Imported equipment (CIF value: Rs 6 million)	7.0
Indigenous equipment (CIF value of similar equipment: Rs 40 million)	50.0
Transport	1.0
Engineering and know-how fees	5.0
Preoperative expenses	4.8
Bank charges	2.0
	80.0

The working capital requirement of the project, consisting only of imported raw materials, will be Rs 16 million (CIF value: Rs 12 million).

The estimated annual profitability of the project is as follows:

Revenues		(Rs in million)
Sales revenue (10,000 tonnes at Rs 10,000 per tonne; CIF price is Rs 7,500 per tonne)		100
Expenses		
Imported raw materials (CIF value: Rs 8 million)		10
Indigenous raw materials and stores		40
Labour		5
Salaries		3
Repairs and maintenance		1
Water, fuel, etc.		5
Electricity		5
Rate	3	
Duty	2	
Depreciation		4
Other overheads		7
Profit		
Taxable profit		20

For the sake of simplicity we may assume that capital costs are incurred at the beginning (i.e., at the end of year 0) and full production begins from year 1 itself.

Given the above information, let us convert the financial costs and benefits into social costs and benefits. We first begin with social costs associated with the initial outlay on the project which consists of capital outlay and working capital. These are shown in Exhibit 14.8. Based on this exhibit, the social cost of initial outlay is worked out as follows:

	(Rs in million)
Tradeable value *ab initio*	70.473
Social cost of tradeable component $= 5.65 / 1.5$	3.767
Social cost of labour component $= 2.75 \times 0.5$	1.375
Social cost of residual component $= 2.60 \times 0.5$	1.300
Total social cost of initial outlay	76.915

EXHIBIT 14.8

Social Costs Associated with the Initial Outlay

(Rs in million)

Item	Financial cost	Basis of conversion	Tradeable value *ab initio*	*T*	*L*	*R*
Land	0.2	SCF = 1/1.5	0.133			
Buildings	10.0	T = 0.50, L = 0.25, R = 0.25		5.00	2.50	2.50
Imported equipment	7.0	CIF value	6.00			
Indigenous equipment	50.0	CIF value of similar equipment	40.0			
Transport	1.0	T = 0.65, L = 0.25, R = 0.10		0.65	0.25	0.10
Engineering and know-how fees	5.0	SCF = 1.50	7.5			
Preoperative expenses	4.80	SCF = 1.0	4.80			
Bank charges	2.00	SCF = 0.02	0.04			
Working capital requirement	16.0	CIF value	12.00			
Total	196.0		70.473	5.65	2.75	2.60

Exhibit 14.9 shows the conversion of operating costs into social costs. Based on this exhibit, the annual social cost of operation is worked out as follows:

		(Rs in million)
Tradeable value *ab initio*	=	50.234
Social cost of tradeable component = 4.63/1.5	=	3.087
Social cost of labour component = 1.64 × 0.5	=	0.821
Social cost of residual component = 1.73 × 0.5	=	0.865
Annual social cost of operations	=	55.007

The annual value of output at CIF prices is Rs 70 million. Hence, the social net benefit per year would be:

70 – 55.007 = Rs 14.993 million.

In addition to this annual net benefit for 15 years, there will be the recovery of working capital worth Rs 12 million at the end of the 15th year.

Putting the above figures together, we find that the stream of costs and benefits associated with the project would be:

Year/s	**Net social benefit** (Rs in million)
0	– 76.015
1 – 14	14.993
15	26.993

The economic rate of return for the project, which is the internal rate of return of the stream of social costs and benefits, is the value of r in the equation:

$$76.915 = \sum_{t=1}^{14} \frac{14.993}{(1+r)^t} + \frac{26.993}{(1+r)^{15}}$$

Solving this equation we find that the economic rate of return is about 19 per cent.

EXHIBIT 14.9

Conversion of Financial Costs into Social Costs

(Rs in million)

Item	Financial cost	Basis of conversion	Tradeable value *ab initio*	*T*	*L*	*R*
Imported raw material	10.00	CIF value	8.00			
Indigenous raw material and stores	40.00	SCF = 0.80	32.00			
Labour	5.00	SCF = 0.50	2.50			
Salaries	3.00	SCF = 0.8	2.40			
Repairs and maintenance	1.00	SCF = 1/1.5	0.667			
Water, fuel, etc.	5.00	T = 0.50, L = 0.25, R = 0.25		2.50	1.25	1.25
Electricity (Rate portion)	3.00	T = 0.71, L = 0.13, R = 0.16		2.13	0.39	0.48
Other overheads	7.00	SCF = 1/1.5	4.667			
Total	74.00		50.234	4.63	1.64	1.73

Effective Rate of Protection

Tariffs, import restrictions, and subsidies are used to encourage domestic industries and protect them against international competition. The extent to which a project is sheltered is measured by the Effective Rate of Protection (*ERP*). It is calculated as follows:

$$\frac{\text{Value added at domestic prices} - \text{Value added at world prices}}{\text{Value added at world prices}}$$

This ratio is multiplied by 100 to express the *ERP* in percentage terms.

The data required for calculating the ERP may be arranged as follows:

	At domestic prices	At world prices
A. Selling price		
B. Input cost		
Traded		
Non-traded		
C. Value added		

The domestic selling price is net of taxes and excise duties but inclusive of a reasonable selling commission. The selling price at world price is the CIF price for imports and FOB for exports.

The input cost consists of the costs of the following inputs:

- Raw materials and stores
- Power, fuel, and water
- Repairs and maintenance
- Part of administrative overheads and expenses
- Selling expenses

The distinction between traded inputs (which are valued both at domestic and world prices) and non-traded inputs (which are valued at domestic price only) is made as follows:

1. *Raw Materials and Stores* In general these are taken as traded items and their value at domestic and world prices (CIF prices) are estimated. However, raw materials which have a low value-to-volume ratio and involve disproportionately high transport cost (like silica and pulp) and which are not imported are regarded as non-traded items.

2. *Power, Fuel, and Water* These are normally treated as 'non-traded' items. However, where fuel is in the form of oil and/or coal and fuel costs are significant, it should be regarded as a traded item and valued at both domestic and world prices.

3. *Repairs and Maintenance* This is a non-traded item. However, when this entails substantial consumption of spares and chemicals (not included in raw materials) it is regarded as a traded item and valued at both domestic and world prices.

4. *Selling Expenses* This is regarded as a non-traded item.

5. *Part of Administrative Overheads and Expenses* Administrative costs may be divided into two parts: labour costs and other expenses (like rent, insurance charges, telephone tariff, etc.). Since labour costs are part of value added, other expenses only are considered as input costs. These are regarded as non-traded items.

The difference between the selling price and input costs is the value added. This represents payment to labour and capital.

Illustration

The calculation of *ERP* may be illustrated with the help of an example. The domestic prices and world prices of the inputs and outputs of a project in a normal year are given in Exhibit 14.10.

The *ERP* in this case is:

$$\frac{\text{Value added at domestic prices} - \text{Value added at world prices}}{\text{Value added at world prices}} = \frac{60-30}{30} = 1 \quad (\text{ or } 100\%)$$

EXHIBIT 14.10

Domestic and World Prices

(Rs in million)

	Domestic prices	World prices
Inputs		
• Tradeable Inputs		
Raw materials	300	250
Consumable stores	50	30
Total	350	280
Inputs		
• Non-tradeable Inputs		
Power, fuel, and water	20	
Repairs and maintenance	15	
Administrative and other overheads	30	
Selling expenses	25	
Total	90	90
• Total Input Costs	440	370
Output		
• Sales Realisation	500	400
• Value Added	60	30

It may be emphasised that when the value added at domestic prices is the same as the value added at world prices, the *ERP* is zero. In such a case, it implies that the project does not enjoy any protection from international competition. When the value added at domestic prices is higher than the value added at world prices, as is often the case, the *ERP* takes a positive value. Clearly, the higher the value of *ERP*, the higher the implied protection enjoyed by the project. It is generally agreed that the extent of protection given to a project should not exceed 30 per cent.

Domestic Resource Cost

The domestic resource cost (*DRC*) is calculated as follows:

$$\frac{\text{Value added at domestic prices}}{\text{Value added at world prices}} \times \text{Exchange rate}$$

For calculating the *DRC*, data may be arranged as shown below:

	Domestic	Imported
Selling price		
Operating Costs		
Raw materials (net of duties and taxes)		
Power, fuel, and water		
Repairs and maintenance		
Administrative overheads and expenses		
Selling expenses		
Capital Costs		
Charge on capital employed		
Depreciation		

A word of explanation is required about the two elements of capital cost: charge on capital employed and depreciation.

Charge on Capital Employed The capital employed consists of fixed assets plus working capital. It is broken down into indigenous and imported components. After deducting taxes and duties from both the components, the charge on capital employed is imputed at 10 per cent.

Depreciation Capital equipments are split into indigenous and imported components. After deducting duties and taxes, depreciation on capital is taken as 6 per cent.

The relationship between the *DRC* and the *ERP* is as follows:

$$DRC = (ERP + 1)\ \text{Exchange rate} \tag{14.7}$$

For example, if the exchange rate is Rs 20 to a dollar, the *DRC* for the illustration given in Exhibit 14.10 will be:

$$DRC = (1 + 1)\ \text{Rs } 20 = \text{Rs } 40$$

This implies that the domestic resource cost (*DRC*) for generating a saving of $1 through the project is Rs 40.

PUBLIC SECTOR INVESTMENT DECISIONS IN INDIA

The public sector has been assigned a pre-eminent role in the Indian economy.

There will be an expanding role for the public sector in several fields. Not only will it be producer of important and strategic goods of basic nature, but it will also be used as a stabilising force for maintaining essential supplies for the consumer.

The public sector today commands a predominant position in many basic industries: coal, crude oil and refining, steel, power, fertilisers, locomotives, basic drugs, machine tools, and so on.

It is somewhat surprising that even though substantial investments were made in the public sector since independence, the mechanisms of appraisal and selection were rather primitive till the middle of sixties. For a long time the important proposals were appraised by the Expenditure Finance Committee that used procedures which were rather slip-shod. This is obvious from an examination of the memos of the Expenditure Finance Committee that clearly made a short shrift of economic considerations.

Initiatives to Improve the Quality of Investment Decisions

The need for preparing feasibility studies was perhaps first highlighted by the committee on 'utilisation of external assistance' which observed that "the delay in foreign aid utilisation is due to the dearth of well conceived projects ready for immediate implementation." Triggered by this awareness and a felt need to improve the quality of project planning and strengthen the public investment decision making process in India, the following steps were taken:

- In 1965, the Government of India set up a separate Bureau of Public Enterprises (BPE, hereafter), with the objective of "integrating and strengthening the arrangement for economic coordination and evaluation of technical, economic, and financial aspects of projects and the working of public enterprises in India." The BPE is an autonomous organisation under the Ministry of Finance and is required to supervise and regulate all aspects of public sector projects.
- In 1965, the Planning Commission prepared and circulated a *Manual of Feasibility Studies for Public Sector Projects*. This manual outlines in detail the procedure required to be adopted for project formulation.
- In 1972, the Government of India set up a special division in the Planning Commission called the Project Appraisal Division (PAD, hereafter) to appraise the central sector projects from the national viewpoint and to make observations regarding the economic viability of investment projects whose capital cost exceeds a certain limit. The PAD has been entrusted with the work of developing a research methodology and other steps required to evolve systematic project planning in India. The PAD has prepared and circulated the *Guidelines for the Preparation of Feasibility Reports for Industrial Projects*.
- In 1972, the Government of India set up a high-powered Public Investment Board (PIB, hereafter) with a view to evolving a scientific procedure for taking investment decisions. The functions assigned to the PIB are: (a) examination of the broad contours of investment proposals in the project formulation stage based on which a decision to prepare the feasibility report would be taken; (b) taking investment decisions on proposals for public investment to produce goods and services; and (c) consideration of proposals for revision of cost estimates which exceed those approved at the time of investment decisions.

Since the appraisal of the PAD and the recommendations of the PIB have an important bearing on public sector investments in India, we will examine their role in some detail. Before doing that, let us first look at the key steps in the public investment decision making process in India.

Key Steps in the Public Investment Decision Making Process in India

Very broadly the principal steps in the public investment decision making process in India are as follows:

1. The Planning Commission formulates the five-year plan indicating the broad strategy of planning, the role of each sector, the physical targets to be achieved by each sector, and the financial outlays to be made available for the development of each sector.
2. The administrative ministries develop sectoral plans. It is in these plans that the projects of the public sector enterprises are identified. The identification of a project provides the green signal for the preparation of its feasibility report.
3. The concerned public sector enterprise prepares the feasibility report and forwards it to its administrative ministry.
4. The administrative ministry carries out a preliminary scrutiny of the feasibility report and sends copies of the same to the various appraising agencies, namely, the Planning Commission, the Department of Economic Affairs and the Plan Finance Division of the Finance Ministry, and the Bureau of Public Enterprises for their comments.
5. The PAD of the Planning Commission carries out a detailed appraisal. The objective of its appraisal is not only to suggest whether to accept or reject the project but also to suggest how it may be re-formulated to enhance its technical, financial, commercial, and economic viability.
6. The Investment Planning Committee of the Planning Commission discusses the appraisal note of the PAD and recommends to the PIB the view of the Planning Commission on whether the project should be accepted, rejected, deferred, reformulated, or redesigned.
7. The PIB considers the (a) appraisal note of the PAD along with the view of the Planning Commission, (b) the comments of the BPE, (c) the comments of the plan finance division of the ministry of finance, and (d) the note of the administrative ministry. If the PIB clears the project, it sends it to the cabinet for its approval.
8. The cabinet generally accepts the recommendation of the PIB and approves its implementation.

Project Appraisal Division

The Project Appraisal Division (PAD) of the Planning Commission was set up in 1972 and entrusted with the following functions:

(a) to suggest standard formats for submission of projects and procedures for their techno-economic evaluation;

(b) to conduct actual techno-economic evaluation of selected major projects and programmes submitted to the Planning Commission;

(c) to assist the state governments and central ministries in giving effect to standardised formats and procedures for project evaluation; and

(d) to undertake and support research leading to progressive refinement of methodology and procedure for project evaluation.

The appraisal notes of the PAD generally cover the following:

(a) project description and background of the investment proposal, (b) plan and project, (c) justification for the project, (d) demand and market analysis, (e) choice of technology and proposed capacity, (f) gestation period, project life, capacity utilisation, production build-up, product-mix, infrastructural requirements and availability, (g) capital costs and norms, (h) operating costs and norms, (i) possibilities of cost minimisation, (j) possible alternatives and the least cost option, (k) financial analysis by DCF method and sensitivity analysis, and (l) social profitability analysis and sensitivity analysis.

In the economic appraisal (also referred to as social profitability analysis) of industrial projects[8], the methodology followed by the PAD is a modified version of the Little-Mirrlees approach. The key elements of the methodology adopted by the PAD are as follows:

1. All tradeable inputs are valued at border prices.
2. Transfer cost items (taxes, duties, etc.) are ignored.
3. All non-tradeable items, especially power and transport, are evaluated in terms of marginal cost.
4. Foreign exchange involved in the inputs and outputs are valued at specified premia.
5. Social wage rates (or shadow wage rates) are applied to the unskilled and semi-skilled labour[9].
6. The nume'raire is defined as savings in domestic rupees rather than foreign exchange (as recommended by the Little-Mirrlees approach).

Public Investment Board

The Public Investment Board (PIB) is a committee of secretaries which appraises and recommends all central public sector projects[10] involving an outlay exceeding a certain amount[11] . Besides the Secretary, Expenditure, Ministry of Finance, who serves as its chairman, the PIB has the following members: Secretary, Economic Affairs, Ministry of Finance, Secretary, Planning Commission, Secretary, Industrial Development, Secretary to Prime Minister, and Secretary to the administrative ministry concerned with the investment proposal. The Director General of the BPE and the Adviser, PAD are permanent invitees to the PIB.

The PIB is assisted by various agencies. The Plan Finance Division of the Ministry of Finance, which functions as the secretariat of the PIB, scrutinises the proposals particularly with reference to budgetary and plan provisions. The BPE examines construction costs, technical aspects, and financial aspects. The PAD of the Planning Commission provides assistance in economic appraisal and examines critical assumptions underlying the project. The Integrated Financial Adviser in the sponsoring ministry furnishes the feasibility study and provides whatever additional information is called for by the PIB.

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[8] The projects forwarded to the PAD are divided into three broad categories: (i) industrial projects, (ii) infrastructural projects, and (iii) social projects. Our discussion focuses on the economic appraisal of industrial projects.

[9] Reflecting the employment and income generation aspect of the project, the social wage rate varies from state to state and from urban to rural location. In general, it ranges between 40 per cent and 70 per cent of the monetary wage rate.

[10] Other than the projects of departmental undertakings like the Railways and Ordnance Factories which have their own procedures for project evaluation and sanction.

[11] For projects involving smaller outlays, decision making powers have been decentralised as follows: (a) Public sector undertakings have complete autonomy for projects up to specified ceilings depending on their gross blocks. (b) Administrative ministries have complete or partial autonomy within certain ceilings. (c) Expenditure Finance Committee is empowered to decide for certain types of projects within specified cost ceilings.

The guidelines followed by the PIB in appraising investment proposals are as follows:

(a) The contribution of the project to the economic and social objectives and adherence to the concerned policies of the government.

(b) The advisability of undertaking the project in the public sector or the joint sector or leaving it to the private sector.

(c) Availability of plan funds and desirability of diversion of plan funds to the new project from those already on hand.

(d) The plan capacity and the timing of investment in the light of supply and demand balance including export possibilities of the product / service.

(e) The economic benefits of the project as distinct from financial returns.

(f) Crucial assumptions in the feasibility report that are likely to affect the performance of the commissioned project in relation to the claims made thereon in the feasibility report.

(g) Major technological and constructional aspects which may have a bearing on the investment decision.

Lacunae

The institution of the PIB (and its technical arm, the PAD) represents an important advance in the process of public investment decision making in India. It has (a) promoted a more scientific appraisal of investment projects, (b) provided a forum for bringing to bear an integrated approach to project appraisal and selection, (c) expedited the process of decision making, and (d) strengthened the hands of the government to resist pressures based on non-economic considerations to a certain extent.

Despite these improvements, public investment decision making in India, as the critics argue, suffers from the following deficiencies:

- Lack of detailed disaggregative sectoral planning
- Pre-emptive advance commitments
- Practice of submitting projects of the same sector/undertaking in a piecemeal manner
- Insufficient generation and analysis of options
- Preparation of feasibility reports without adequate studies / investigations
- Avoidable overlap in the appraisal of several agencies
- Tardy clearance procedures
- Sacrifice of economic considerations at the altar of political expediency
- Emphasis on procedures rather than substance

SUMMARY

- Social Cost Benefit Analysis (SCBA) is a methodology for evaluating projects from the social point of view. In the context of planned economies, SCBA aids in evaluating individual projects within the planning framework.

- In SCBA the focus is on social costs and benefits of a project. These often tend to differ from the costs incurred in monetary terms and benefits earned in monetary terms by the project. The principal reasons for discrepancy are: (i) market imperfections, (ii) externalities, (iii) taxes, (iv) concern for savings, (v) concern for redistribution, and (vi) merit and demerit goods.
- Towards the end of the sixties and early seventies two principal approaches for SCBA emerged: UNIDO approach and Little-Mirrlees approach.
- The UNIDO method of project appraisal involves five stages: (i) calculation of the financial profitability of the project measured at market prices; (ii) obtaining the net benefit of the project measured in terms of economic (efficiency) prices; (iii) adjustment for the impact of the project on savings and investment; (iv) adjustment for the impact of the project on income redistribution; and (v) adjustment for the impact of the project on merit and demerit goods.
- The measurement of financial profitability of the project in stage one is similar to the financial evaluation discussed at great length in the previous chapters of this book.
- Stage two is concerned with the determination of the net benefit of the project in terms of economic (efficiency) prices also referred to as shadow prices.
- A key issue in shadow pricing is whether a good is tradeable or not. For a traded good, the shadow price is the border price, translated in domestic currency at market exchange rate. The shadow price of a non-traded good is measured in terms of consumer willingness to pay or cost of production depending on the impact of the project on the rest of the economy.
- Since SCBA seeks to consider all costs and benefits, to whomsoever they may accrue, external effects also need to be taken into account. The valuation of external effects is rather difficult because they are often intangible in nature and there is no market price which can be used as a starting point.
- The principles of shadow pricing for goods may be applied to labour as well, though labour is considered to be service. When a project takes labour away from other employments, the shadow price of labour is equal to what other users of labour are willing to pay. The shadow price associated with inducing 'additional' production of workers consists of the marginal product of labour in previous employment plus certain other costs.
- The opportunity cost of capital depends on how the capital required for the project is generated. To the extent that it comes from additional savings, its opportunity cost is measured by the consumption rate of interest; to the extent that it comes from the denial of capital to alternative projects, its opportunity cost is the rate of return that would be earned from those alternative projects. In practice, the consumption rate of interest may be used as the discount rate because in stage three of UNIDO method all inputs and outputs are converted into their consumption equivalents.
- The UNIDO method uses domestic currency as the nume'raire. So the foreign exchange impact of the project must be identified and valued. The UNIDO method determines the shadow price of foreign exchange on the basis of marginal social value as revealed by the consumer willingness to pay for the goods that are allowed to be imported at the margin.

- Stage three of the UNIDO method seeks to answer the following questions: Given the income distribution impact of the project what would be its effect on savings? What is the value of such savings to the society? The savings impact of a project is equal to:

$$\sum \Delta Y_i \, MPS_i$$

The shadow price (value) of a rupee of savings, given certain simplifying assumptions, is equal to:

$$\frac{r(1-a)}{k-ar}$$

- Stage four of the UNIDO method is concerned with measuring the impact of the project on income redistribution. This calls for suitably weighting the net gain or loss to various groups in the society and summing them.
- The Little-Mirrlees (L-M) approach to SCBA has considerable similarity with the UNIDO approach. However, there are certain important differences as well.
- As per the L-M approach, the outputs and inputs of a project are classified into the following categories: (i) traded goods and services, (ii) non-traded goods and services and (iii) labour.
- The shadow price of a traded good is simply its border price. If a good is exported its shadow price is its FOB price and if a good is imported its shadow price is its CIF price. The shadow prices for non-traded items are defined in terms of marginal social cost and marginal social benefit.
- The L-M approach suggests the following formula for calculating the shadow wage rate (SWR):

$$SWR = c' - \frac{1}{s}\,(c-m)$$

- While the all-India term-lending institutions —IDBI, IFCI, and ICICI— approach project proposals primarily from the financial point of view, they also evaluate them from the larger social point of view.
- Though there are some minor variations, the three institutions follow essentially a similar approach which is a simplified version of the L-M approach.
- IDBI, the apex term-lending financial institution, considers three aspects in its economic appraisal of industrial projects: economic rate of return, effective rate of protection, and domestic resource cost.
- The economic rate of return is simply the internal rate of return of the stream of social costs and benefits.
- The effective rate of protection is calculated as follows:

$$\frac{\text{Value added at domestic prices} \; - \; \text{Value added at world prices}}{\text{Value added at world prices}} \times 100$$

- The domestic resource cost is calculated as follows:

$$\frac{\text{Value added at domestic prices}}{\text{Value added at world prices}} \times \text{Exchange rate}$$

- Till the middle of the sixties the mechanism for appraisal and selection of public sector projects was rather primitive. To improve the quality of project planning and strengthen the public investment decision making process several steps were taken: creation of the

Bureau of Public Enterprises; establishment of the Project Appraisal Division (PAD) in the Planning Commission; and institution of the Public Investment Board (PIB).

- In the economic appraisal (also referred to as social profitability analysis) of industrial projects, the PAD follows a modified version of the Little-Mirrlees approach.
- The PIB is a committee of secretaries which appraises and recommends all central public sector projects involving an outlay exceeding a certain amount. (For projects involving smaller outlays the decision making powers have been decentralised.)
- The institution of the PIB (and its technical arm the PAD) represents an important advance in the process of public investment decision making in India. It has promoted a more systematic approach to public sector investment decision making. Yet, there are serious lacunae which have marred the quality of public investment decisions in India.

QUESTIONS

1. Discuss the principal sources of discrepancy between social costs and benefits on the one hand and monetary costs and benefits on the other.
2. What are the five stages of appraisal in the UNIDO method as described in the *Guide to Practical Project Appraisal*?
3. What questions are raised in defining the nume'raire? How is the UNIDO nume'raire specified ?
4. Explain what is the consumer willingness to pay?
5. As per the UNIDO method, how are the following valued?
   (a) tradeable inputs and outputs
   (b) non-tradeable inputs and outputs
   (c) labour
   (d) foreign exchange
   (e) savings
6. What are the similarities and differences between the UNIDO approach and the Little-Mirrlees approach?
7. How are the following defined or determined in the Little-Mirrlees approach:
   (a) shadow price of traded goods
   (b) accounting price of non-traded goods
   (c) shadow wage rate
   (d) accounting rate of return
8. What are the key elements of the method used by IDBI to calculate the economic rate of return?
9. What is the 'effective rate of protection' and the 'domestic resource cost'? How are the two related?
10. Discuss the initiatives taken to improve the quality of public investment decision making in India.
11. What are the principal steps involved in the public investment decision making process in India?
12. Discuss the role of the PAD and the PIB.
13. What are the key elements of the methodology adopted by the PAD for economic appraisal?
14. What deficiencies characterise public investment decision making in India ?

PROBLEMS

1. A government is considering building a tunnel across a sea channel which can currently only be crossed by ship. The following information is available.
   - (i) The tunnel will consist of a two-track railway and cars and passengers will be carried by train. It will cut crossing time by two hours for cars and passengers.
   - (ii) The relevant categories of traffic are:
     - (a) cars (and their passengers)
     - (b) passengers not in cars
     - (c) freight
   - (iii) The authorities who would operate the tunnel have decided to charge a toll which would maximise revenue. The toll that they have decided to charge is Rs 160 per car which compares favourably with the charge by ship which is Rs 200.
   - (iv) Because of the quicker and cheaper journeys available, it is forecast that the following traffic per year for the foreseeable future will be diverted from the existing method of travel:
     75,000 cars (with an average of two passengers)
     50,000 passengers not in cars
     350,000 tonnes of freight
     In addition 50,000 extra car journeys(with two passengers each) will be made.
   - (v) The average value of passenger time is Rs 6 per hour.
   - (vi) The diverted traffic will reduce the cost of operation of existing ship by Rs 40 million a year, while at the forecast levels of traffic, the maintenance and operating cost of the tunnel will be Rs 3 million. Its capital cost will be Rs 400 million. The life of the tunnel will be 50 years.
   - (vii) Assuming that the monetary figures given above reflect social value, calculate the IRR of the stream of social costs and benefits.

2. A government is considering whether it should close down the branch line passenger services from station A to station B. No goods are currently carried by rail.
   The chief accountant of the government estimates the annual cost of train movement, track maintenance, signalling, and other expenses to be Rs 1,520,000, including Rs 120,000 toward depreciation and interest charges.
   If the line were closed at any time, the diesel train operating on it could be sold to another country for Rs 240,000. Nothing else has any re-sale value. The line is used for 1,000 single journeys each day (250 days per year). The single fare is Rs 4.00. So the line is losing money, a deficit met by taxation.
   If the line is closed, it is estimated that of the former journeys, 800 will be made by bus (at the same fare), and 200 will not be made. The bus fare is the same as the rail fare and the extra bus fares exactly offset the bus operations' extra cost. Bus journey takes an average of 40 minutes longer than the rail journey. The average value of passengers' time is Rs 2 per hour. Enumerate the social costs and benefits associated with the proposal.

3. The economic planning department of a state is considering a proposal to build an 80-mile road from a capital to a village which has hitherto only been accessible by river boat. The road will cost Rs 24 million and the annual maintenance charges will be approximately Rs 1 million. The social discount rate is 10 per cent. Analysis suggests that the following effects are likely to result from the completion of the road:
   - (i) A saving of Rs 0.5 million per year on the cost of shipping agricultural produce from the village and its surrounding area.

(ii) The opening up to development of an additional 50,000 acres of land. Development will cost Rs 3,000 per acre and produce, after 5 years, crops worth Rs 1,000 per acre per year. The land will be settled by small holders, who will move from other employments where their earnings average Rs 1,500 per year. An estimated 8,000 small holdings will be provided. Land clearing and drainage cost will be borne by the government, and each settleor will receive a grant of Rs 5,000 to assist him in meeting relocation costs. Prior to the time the main crop becomes established, other crops yielding Rs 200 per acre per year can be grown.

(iii) The land after development will be worth Rs 380 million whereas its present value as timber land is just Rs 100 million.

(iv) Tax revenue from the area will be increased by Rs 1million per year.

(v) Value of timber output will be increased by Rs 20 million in the first year, while the land is being cleared, but will be reduced by Rs 4 million per year after the clearing.

(vi) The income of boat operators on the river will be reduced by Rs 0.5 million per year. Boats costing Rs 3 million and scheduled for replacement in five years will not be replaced, and the labour displaced will be absorbed elsewhere at equivalent wages.

Which of the effects listed above should be taken into account in the social cost benefit analysis? Should the road be built?

4. A project for manufacturing a product which is currently being imported in the country is being appraised. The project would have a life of 20 years and it will lead to import substitution. The capital outlay on the project is expected to be as follows:

	(Rs in million)
Land	0.30
Buildings	12.00
Imported equipment	15.00
(CIF value: Rs 9 million)	
Indigenous equipment	80.00
(CIF value of similar equipment: Rs 60 million)	
Transport	2.00
Engineering and know-how fees	6.00
Pre-operative expenses	6.00
Bank charges	3.70

The working capital requirement of the project, consisting only of domestic raw materials, will be Rs 25 million.

The estimated annual profitability of the project is as follows:

	(Rs in million)
Revenue	
Sales revenues	150
(CIF value of the output is Rs 110 million)	
Expenses	
Raw materials and stores	85
Labour	7
Salaries	5
Repairs and maintenance	1.2
Water, fuel, etc.	6

(Continued)

(Continued)

Revenue	(Rs in million)
Electricity	7
Rate 5	
Duty 2	
Depreciation	4.8
Other overheads	10
Profit	
Taxable profit	24

For the sake of simplicity we may assume that capital costs are incurred at the beginning (i.e., at the end of year 0) and full production begins from year 1 itself. Using the social conversion factors employed by IDBI, calculate the economic rate of return for the project.

15

Multiple Projects and Constraints

When investment projects are considered individually any of the discounted cash flow criteria—net present value, internal rate of return, or benefit cost ratio—may be applied for obtaining a correct "accept or reject" signal. In an existing organisation, however, capital investment projects often cannot be considered individually or in isolation. This is because the pre-conditions for viewing projects individually—project independence, lack of capital rationing, and project divisibility—are rarely, if ever, fulfilled. Under the constraints obtaining in the real world, the so-called rational criteria *per se* may not necessarily signal the correct decision.

This chapter explains the nature of constraints which render "selection of projects in isolation" meaningless, discusses the problems with the method of ranking, and shows how the techniques of mathematical programming may be employed to select the capital budget in face of constraints. It is organised into six sections as follows.

- Constraints
- Method of ranking
- Mathematical programming approach
- Linear programming model
- Integer linear programming model
- Goal programming model

CONSTRAINTS

Project Dependence

Projects *A* and *B* are economically independent if the acceptance or rejection of one does not change the cash flow stream or does not affect the acceptance or rejection of the other. For example, an investment in a power press and an investment in a computer installation are economically independent. On the other hand, Projects *A* and *B* are economically dependent if the acceptance or rejection of one changes the cash flow stream of the other or affects the acceptance or rejection of the other.

What kinds of economic dependency are found among projects? The most conspicuous kind of economic dependency occurs when projects are mutually exclusive. If two or more projects are mutually exclusive, acceptance of any one project out of the set of mutually exclusive projects automatically precludes the acceptance of all other projects in the set. From an economic point of view, mutually exclusive projects are substitutes for each other. For example, the alternative possible uses of a building represent a set of mutually exclusive projects. Clearly if the building is put to one use, it cannot be put to any other use.

A second kind of economic dependency exists when projects, even though not mutually exclusive, negatively influence each other's cash flows if they are accepted together. Bierman and Smidt have given an excellent illustration of this kind of economic dependency: a project for building a toll bridge and a project for operating a toll ferry. These two projects are such that when they are undertaken together, the revenues of one will be negatively influenced by the other.

A third kind of economic dependency, which may be referred to as positive economic dependency, occurs when there is complementarity between projects. If undertaking a project influences favourably the cash flows of another project, the two projects are complementary projects. Complementarity may be of two types: asymmetric complementarity and symmetric complementarity. In asymmetric complementarity, the favourable effect extends only in one direction. For example, project *A* favourably influences the cash flows of project *B* whereas project *B*, in turn, has no influence on the cash flows of project *A*. In symmetric complementarity the favourable effect extends in both directions: project *A* has favourable influence on the cash flows of project *B* and, likewise, project *B* has favourable influence on the cash flows of project *A*.

Capital Rationing

Capital rationing exists when funds available for investment are inadequate to undertake all projects which are otherwise acceptable. (It may be recalled that a project is acceptable if the net present value is greater than zero or the internal rate of return is greater than the cost of capital or the benefit-cost ratio is greater than one.)

What are the sources of capital rationing? Capital rationing may arise because of an internal limitation or an external constraint. Internal capital rationing is caused by a decision taken by management to set a limit to its capital expenditure outlays; or, it may be caused by a choice of hurdle rate higher than the cost of capital of the firm. Internal capital rationing, in either case, results in rejection of some investment projects which otherwise are acceptable.

External capital rationing arises out of the inability of the firm to raise sufficient amounts of funds at a given cost of capital. In a perfect market, a firm can obtain all its funds requirement at a given cost of capital. In the real world, however, the firm can raise only a limited amount of funds at a given cost of capital. Beyond a certain point, the cost of capital tends to increase as shown in Exhibit 15.1.

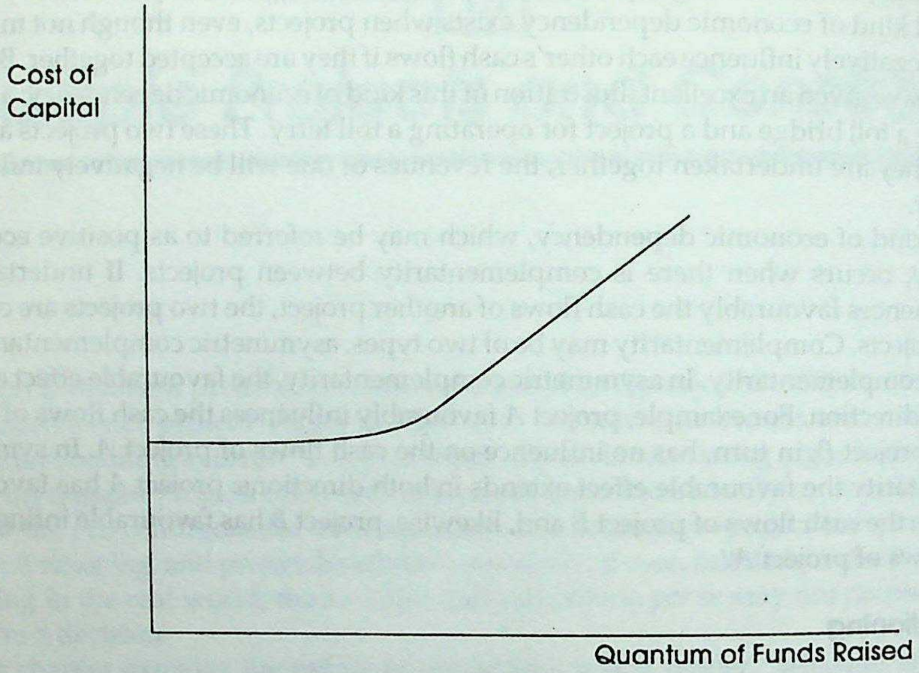
What is the implication of a capital supply curve of the kind shown in Exhibit 15.1? The implication of a rising capital supply curve is that some projects which would be acceptable if the cost of capital were constant will have to be postponed or abandoned.

Project Indivisibility

Capital projects are considered indivisible, i.e. a capital project has to be accepted or rejected in toto—a project cannot be accepted partially.

EXHIBIT 15.1

Behaviour of Cost of Capital



Given the indivisibility of capital projects and the existence of capital rationing, the need arises for comparing projects. To illustrate this point, consider an example. A firm is evaluating three projects *A*, *B*, and *C* which involve an outlay of Rs 0.5 million, Rs 0.4 million, and Rs 0.3 million respectively. The net present value of these projects are Rs 0.2 million, Rs 0.15 million, and Rs 0.1 million respectively. The funds available to the firm for investment are Rs 0.7 million. In this situation, acceptance of project *A* (project with the highest net present value) which yields a net present value of Rs 0.2 million results in the rejection of projects *B* and *C* which together would yield a combined net present value of Rs 0.25 million. Hence, because of indivisibility of projects, there is need for comparison of projects before the acceptance/rejection decisions are taken.

METHOD OF RANKING

Because of economic dependency, capital rationing, or project indivisibility, a need arises for comparing projects in order to accept some and reject others. What approaches are available for determining which projects to accept and which projects to reject? Basically, two approaches are available: (i) the method of ranking, and (ii) the method of mathematical programming. This section discusses the method of ranking; the following section discusses the method of mathematical programming.

Fairly simple, the method of ranking consists of two steps: (i) Rank all projects in decreasing order according to their individual *NPV*'s, *IRR*'s, or *BCR*'s. (ii) Accept projects in that order until the capital budget is exhausted.

The method of ranking, originally proposed by Joel Dean is seriously impaired by two problems: (i) conflict in ranking as per discounted cash flow criteria, and (ii) project indivisibility.

Conflict in Ranking

In a given set of projects, preference ranking tends to differ from one criterion to another. For example, *NPV* and *IRR* criteria may yield different preference rankings. Likewise, there may be a discrepancy between the preference rankings of *NPV* and *BCR* (benefit cost ratio) criteria. When preference rankings differ, the set of projects selected as per one criterion tends to differ from the set of projects selected as per some other criterion. This may be illustrated by an example.

Consider a set of five projects, *A*, *B*, *C*, *D*, and *E*, for which the investment outlay, expected annual cash flow, and project life are as shown below:

Project	Investment outlay	Expected annual cash flow	Project life
	(Rs)	(Rs)	(Years)
A	10,000	4,000	12
B	25,000	10,000	4
C	30,000	6,000	20
D	38,000	12,000	16
E	35,000	12,000	9

The *NPV*, *IRR*, and *BCR* of the five projects and the ranking along these dimensions are shown in Exhibit 15.2.

It is clear that in the above case the three criteria rank the projects differently. If there is no capital rationing all the projects would be accepted under all the three criteria though internal ranking may differ across criteria. However, if the funds available are limited, the set of projects accepted would depend on the criterion adopted.

What causes ranking conflicts? Ranking conflicts are traceable to differing assumptions made about the rate of return at which intermediate cash flows are re-invested. The differing re-investment rate assumptions underlying the three *DCF* criteria are discussed below.

Re-Investment Assumption Underlying the Net Present Value Criterion

The *NPV* method is based on the assumption that the intermediate cash flows are re-invested at a rate of return equal to the cost of capital of firm. To demonstrate this point, consider two mutually exclusive projects, *X* and *Y*, which have lives of m and n years respectively ($m < n$).

EXHIBIT 15.2

NPV, IRR, and *BCR* for the Five Projects

Project	*NPV* (Rs)	*NPV* Ranking	*IRR* (Per cent)	*IRR* Ranking	*BCR*	*BCR* Ranking
A	14,776	4	39	1	2.48	1
B	5,370	5	22	4	1.21	5
C	14,814	3	19	5	1.49	4
D	45,688	1	30	2	2.20	2
E	28,936	2	29	3	1.83	3

	X	*Y*
Initial outlay	$A_{x,0}$	$A_{y,0}$
Cash inflow at the end of *m* years	$C_{x,m}$	–
Cash inflow at the end of *n* years	–	$C_{y,n}$

Let *k* be the firm's cost of capital and *j* the re-investment rate on the cash inflow. (Assume initially that $j \neq k$.)

The *NPV*s of the two projects, *X* and *Y*, with re-investment rate applied to the shorter-lived project, *X*, are:

$$NPV\,(X) = \frac{C_{x,m}\,(1+j)^{n-m}}{(1+k)^{n}} - A_{x,0}$$

$$= \frac{C_{x,m}\,(1+j)^{n-m}}{(1+k)^{m}\,(1+k)^{n-m}}\,A_{x,0}$$

$$= \frac{C_{x,m}}{(1+k)^{m}}\left(\frac{1+j}{1+k}\right)^{n-m} - A_{x,0} \tag{15.1}$$

$$NPV\,(Y) = \frac{C_{y,n}}{(1+k)^{n}} - A_{y,0} \tag{15.2}$$

The *NPV*s of *X* and *Y*, expressed without applying a re-investment rate for the cash inflow of X, the shorter-lived project, are:

$$NPV\,(X) = \frac{C_{x,m}}{(1+k)^{m}} - A_{x,0} \tag{15.3}$$

$$NPV\,(Y) = \frac{C_{y,n}}{(1+k)^{n}} - A_{y,0} \tag{15.4}$$

While the *NPV* of *Y* is same in both the cases, the *NPV* of *X* would be the same in both the cases, provided

$$\frac{C_{x,m}}{(1+k)^m}\left(\frac{1+j}{1+k}\right)^{n-m} - A_{x,0} = \frac{C_{x,m}}{(1+k)^m} - A_{x,0} \qquad (15.5)$$

This implies that

$$\left(\frac{1+j}{1+k}\right)^{n-m} \text{ should be equal to 1.}$$

This happens when $j = k$.

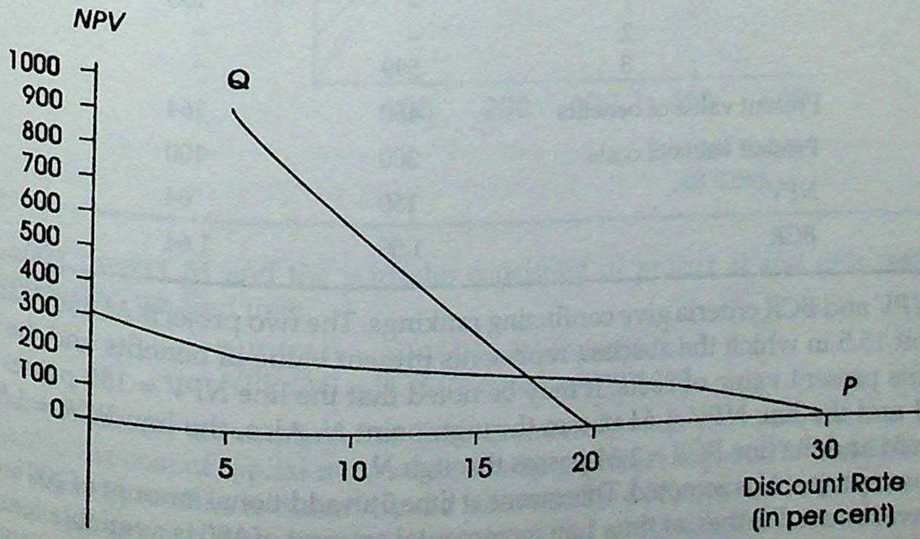
Re-investment Assumption Underlying the Internal Rate of Return Criterion

To understand the re-investment assumption underlying the *IRR* criterion we have to first define a point called the *Fisher's intersection* point. To illustrate the nature of this point, consider two projects *P* and *Q*. Project *P* involves an outlay of Rs. 1,000 at time $t = 0$ and returns Rs 1,300 at the end of year 1; project *Q* also involves an outlay of Rs 1,000 at time $t = 0$ but returns Rs 2,488 at the end of year 5.

The *IRR* of project *P* is 30 per cent whereas the *IRR* of project *Q* is 20 per cent. The *NPV* profiles of the two projects are shown in Exhibit 15.3. From this figure we find that (i) the *NPV* criterion ranks project *Q* as more desirable than project *P* when the discount rate is less than 17.5 per cent; (ii) the *NPV* criterion ranks the two projects alike when the discount rate is equal to 17.5 per cent; and (iii) the *NPV* criterion ranks project *P* as more desirable than project *Q* when the discount rate exceeds 17.5 per cent.

EXHIBIT 15.3

NPV **Profiles of Projects** *P* **and** *Q*



The discount rate at which the *NPV* of the two projects is alike—which in the above case is 17.5 per cent—is referred to as the Fisher's intersection point because it is conceptually equivalent to Irwing Fisher's rate of return over cost.

Now that we know what the Fisher's intersection point is, we are ready to define the re-investment assumption underlying the *IRR* criterion. *The IRR criterion assumes that cash inflows are re-invested at a rate of return equal to or greater than the Fisherian rate of return.* When the re-investment rate is greater than the Fisherian rate of return the ranking conflict between *NPV* and *IRR* criteria disappear.

It may, however, be noted that the Fisherian rate of return over cost may not exist because the *NPV* profiles of two competing projects may not intersect. There is yet another possibility. The *NPV* profiles of the two competing projects may intersect more than once. If the *NPV* profiles do not intersect, the two criteria, *NPV* and *IRR*, provide the same ranking, irrespective of the re-investment rate. If multiple intersections obtain, there are several re-investment rates at which the two projects are equally desirable and interpretation is difficult in such a case.

Re-investment Assumption Underlying the Benefit-Cost Criterion

To understand the re-investment assumption underlying the *BCR*, let us consider a situation where there are two projects, *M* and *N*, whose characteristics are given in Exhibit 15.4.

EXHIBIT 15.4

Characteristics of Two Competing Projects *M* and *N*

Characteristic	Project *M*	Project *N*
Cash flows at t = 0	– 300	– 100
1	–	180
2	–	–
3	599	–
Present value of benefits	450	164
Present value of costs	300	100
NPV	150	64
BCR	1.50	1.64

The *NPV* and *BCR* criteria give conflicting rankings. The two projects *M* and *N* are shown in Exhibit 15.5 in which the abscissa represents present value of benefits and the ordinate represents present value of costs. It may be noted that the line *NPV* = 150 passes through point *M* and the line *NPV* = 64 passes through point *N*. Also, the line *BCR* = 1.50 passes through *M* and the line *BCR* = 1.64 passes through *N*.

Suppose project *N* is accepted. This means at time 0 an additional amount of 200 is available for re-investment. Further, at time 1 an incremental amount of 180 is available for re-investment. If these two amounts are re-invested at the firm's cost of capital up to the end of three years (the horizon for the longer-duration project *M*), the *NPV* of the portfolio consisting of *N* and the re-investments is:

$$\frac{200\,(1.10)^3}{(1.10)^3} + \frac{180\,(1.10)^2}{(1.10)^3} - 300 = 64$$

Thus the *NPV* of the portfolio consisting of *N* and re-investments is same as the *NPV* of *M* alone.

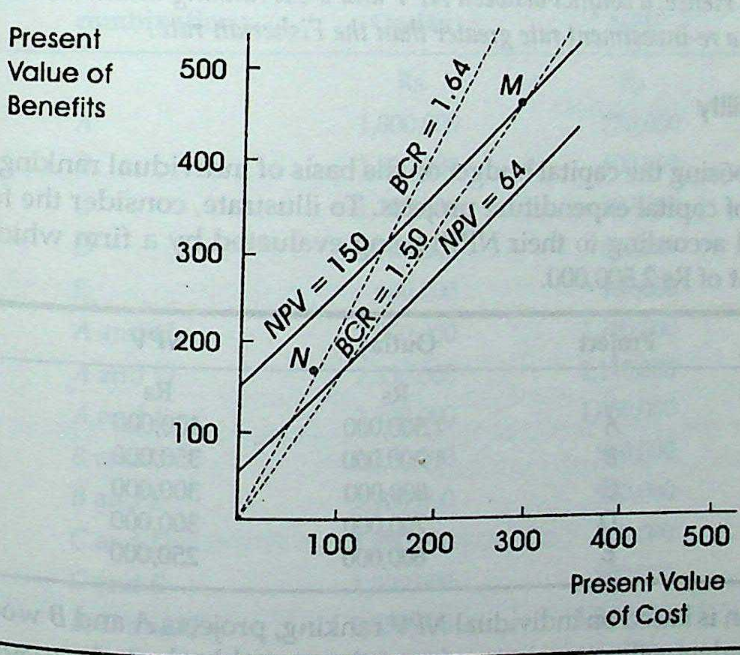
What happens to the *BCR*? The *BCR* of the portfolio of *N* and re-investments is:

$$\frac{\dfrac{200\,(1.10)^3}{(1.10)^3} + \dfrac{180\,(1.10)^2}{(1.10)^3}}{300} = 1.21$$

Thus, though the *NPV* remains unchanged, the *BCR* changes from 1.64 to 1.21.

EXHIBIT 15.5

Graphical Representation of Projects *M* and *N*



Comparing project *M* and the portfolio consisting of project *N* and re-investment of incremental funds, we find that:

$$NPV\,(M) > NPV\,(N + \text{Re-investments})$$
$$NPV\,(M) > BCR\,(N + \text{Re-investments})$$

This means that the assumption that the incremental funds are re-invested at a rate of return equal to the cost of capital removes the ranking conflict as per *NPV* and *BCR* criteria. Hence, the ranking conflict is caused by the failure of the *BCR* criterion to assume that the re-investment occurs at a rate of return equal to the cost of capital.

If the *BCR* criterion fails to assume a re-investment rate equal to the cost of capital, what re-investment rate, if any, does it assume? To answer this question, let us analyse the incremental cash flow stream between *M* and *N*, which is shown below:

Time	Cash flow of M	Cash flow of N	Cash flow of (*M–NiiL*
0	– 300	– 100	– 200
1	–	100	– 180
2	–	–	–
3	599	–	599

The discount rate at which the cash flows of $M - N$ becomes zero is the discount rate at which the firm becomes indifferent between M and N. This rate is the value of i^* in the following equation:

$$0 = -200 - \frac{180}{(1+i^*)} + \frac{599}{(1+i^*)^3}$$

i^*, which in the above equation is about 19.5 per cent, is nothing but the Fisherian rate discussed earlier. *Hence, a conflict between NPV and BCR ranking means that the BCR criterion implicitly assumes a re-investment rate greater than the Fisherian rate.*

Project Indivisibility

A problem in choosing the capital budget on the basis of individual ranking arises because of indivisibility of capital expenditure projects. To illustrate, consider the following set of projects (ranked according to their *NPV*) being evaluated by a firm which has a capital budget constraint of Rs 2,500,000.

Project	Outlay	*NPV*
	Rs	Rs
A	1,500,000	400,000
B	1,000,000	350,000
C	800,000	300,000
D	700,000	300,000
E	600,000	250,000

If the selection is based on individual *NPV* ranking, projects *A* and *B* would be included in the capital budget—these projects exhaust the capital budget. A cursory examination, however, would suggest that it is more desirable to select projects *B*, *C*, and *D*. These three projects can be accommodated within the capital budget of Rs 2,500,000, and have a combined *NPV* of Rs 850,000 for projects *A* and *B*.

Feasible Combinations Approach

The above example suggests that the following procedure may be used for selecting the set of investments under capital rationing.[1]

1. Define all combinations of projects which are feasible, given the capital budget restriction and project inter-dependencies.
2. Choose the feasible combination that has the highest *NPV*.

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[1] This procedure can also take care of project interdependence.

To illustrate this procedure, consider the following projects that are being evaluated by a firm which has a capital budget constraint of Rs 3,000,000.

Project	Outlay	*NPV*
	Rs	Rs
A	1,800,000	750,000
B	1,500,000	600,000
C	1,200,000	500,000
D	750,000	360,000
E	600,000	300,000

Projects *B* and *C* are mutually exclusive. Other projects are independent.
Given the above information the feasible combinations and their *NPV* s are shown below:

Feasible combination	Outlay	*NPV*
	Rs	Rs
A	1,800,000	750,000
B	1,500,000	600,000
C	1,200,000	500,000
D	750,000	360,000
E	600,000	300,000
A and C	3,000,000	1,250,000
A and *D*	2,550,000	1,110,000
A and *E*	2,400,000	1,050,000
B and *D*	2,250,000	960,000
B and *E*	2,100,000	900,000
C and *D*	1,950,000	860,000
C and *E*	1,800,000	800,000
B, *D* and *E*	2,850,000	1,260,000
C, *D* and *E*	2,550,000	1,160,000

The most desirable feasible combination consists of projects *B*, *D*, and *E* as it has the highest *NPV*.

MATHEMATICAL PROGRAMMING APPROACH

The feasible combinations procedure described above becomes increasingly cumbersome as the number of projects increases and as the number of years in the planning horizon increases. To cope with a problem of this kind, it is helpful to use mathematical programming models. The advantage of mathematical programming models is that they help in determining the optimal solution (the most desirable combination of investments) without explicitly evaluating all feasible combinations.

A mathematical programming model is formulated in terms of two broad categories of equations: (i) the objective function, and (ii) the constraint equations. The objective function represents the goal or objective the decision maker seeks to achieve. Constraint equations represent restrictions—arising out of limitations of resources, environmental restrictions, and managerial policies—which have to be observed. The mathematical model seeks to optimise the objective function subject to various constraints.

The objective function and constraint equations are defined in terms of parameters and decision variables. Parameters represent the characteristics of the decision environment which are given. Decision variables represent what is amenable to control by the decision makers.

Out of the wide variety of mathematical programming models, we shall discuss three types:

- Linear programming model
- Integer programming model
- Goal programming model

LINEAR PROGRAMMING MODEL

The most popular mathematical programming model, the linear programming model is based on the following assumptions:

- The objective function and the constraint equations are linear.
- All the coefficients in the objective function and constraint equations are defined with certainty.
- The objective function is unidimensional.
- The decision variables are considered to be continuous.
- Resources are homogeneous. This means that if 100 hours of direct labour are available, each of these hours is equally productive.

Linear Programming Model of a Capital Rationing Problem

The general formulation of a linear programming model for a capital rationing problem is:

Maximise

$$\sum_{j=1}^{n} NPV_j X_j \tag{15.6}$$

Subject to

$$\sum_{j=1}^{n} CF_{jt} X_j \le K_t \ (t = 0, 1, \ldots, m) \tag{15.7}$$

$$0 \le X_j \le 1 \tag{15.8}$$

where NPV_j = net present value of project j

X_j = amount of project j accepted

CF_{jt} = cash outflow required for project j in period t

K_t = capital budget available in period t.

The following features of the model may be noted.

1. All the input parameters—NPV_j, CF_{jt}, K_t—are assumed to be known with certainty.
2. The X_j decision variables are assumed to be continuous but limited by a lower restriction (0) and an upper restriction (1).
3. The NPV calculation is based on a cost of capital figure which is known with certainty.

Lorie and Savage Problem

In their classic paper, "Three Problems in Rationing Capital," Lorie and Savage[2] discussed the following nine-project, two-period problem:

Project	Net present value (NPV_j)	Cash outflow in period 1 (CF_{j1})	Cash outflow in period 2 (CF_{j2})
1	14	12	3
2	17	54	7
3	17	6	6
4	15	6	2
5	40	30	35
6	12	6	6
7	14	48	4
8	10	36	3
9	12	18	3

The linear programming formulation of this problem is as follows:

Maximise
$$14X_1 + 17X_2 + 17X_3 + 15X_4 + 40X_5 + 12X_6 + 14X_7 + 10X_8 + 12X_9$$

Subject to

$$12X_1 + 54X_2 + 6X_3 + 6X_4 + 30X_5 + 6X_6 + 48X_7 + 36X_8 + 18X_9 + S_i = 50 \quad \text{Funds constraint for year 1}$$

$$3X_1 + 7X_2 + 6X_3 + 2X_4 + 35X_5 + 6X_6 + 4X_7 + 3X_8 + 3X_9 + S_2 = 20 \quad \text{Funds constraint for year 2}$$

$$\left.\begin{array}{lll} X_1 + S_3 = 1 & X_4 + S_6 = 1 & X_7 + S_9 = 1 \\ X_2 + S_4 = 1 & X_5 + S_7 = 1 & X_8 + S_{10} = 1 \\ X_3 + S_5 = 1 & X_6 + S_8 = 1 & X_9 + S_{11} = 1 \end{array}\right] \quad \text{Upper limit on project acceptance}$$

$$X_j \geq 0 \; (\; j = 1, 2, \ldots, 9)$$
$$S_i \geq 0 \; (\; i = 1, 2, \ldots, 11)$$

The linear programming solution for the above problem is shown in Exhibit 15.6. From Exhibit 15.6 we find that

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[2] Lorie, J.H. and L.J. Savage, "Three Problems in Rationing Capital," *Journal of Business*, Vol.28 (Oct 1955), 227-239.

1. The basic variables (variables which take a positive value in the optimal solution) are $X_1, X_3, X_4, X_6, X_7, X_9, S_4, S_7, S_8, S_9$, and S_{10}. Their values are shown in the last column of the tableau ($X_1 = 1.0$; $X_3 = 1.0$; $X_4 = 1.0$; $X_6 = .969697$, and so on).
2. The rest of the variables ($X_2, X_3, X_8, S_1, S_2, S_3, S_5, S_6$, and S_{11}) are non-basic variables, which means that they take a zero value. A value of zero for X_1, X_3, and X_8 means that these three projects are completely rejected in the optimal solution. A value of zero for S_1 and S_2 implies that the budgets of 50 in year 1 and 20 in year 2 are fully exhausted on the six accepted projects.

Extensions to Reflect Other Constraints

The above linear programming model may be extended to incorporate other constraints. Two such extensions are described here.

Carry Forward of Cash The funds constraint embodied in Eq. (15.7) appears somewhat rigid. In practice, funds may be shifted from one period to another. Such a possibility may be reflected in the funds constraint. To illustrate, consider the funds constraint for the first two years.

$$\sum_{j=1}^{n} CF_{j1} X_j \leq K_1 \tag{15.9}$$

$$\sum_{j=1}^{n} CF_{j2} X_j \leq K_2 \tag{15.10}$$

Now, suppose that surplus funds in year 1 can be shifted to year 2 and funds so shifted earn r per cent return. This possibility calls for re-writing the above expressions as follows:

$$\sum_{j=1}^{n} CF_{j1} X_j + SF_1 = K_1 \tag{15.9a}$$

$$\sum_{j=1}^{n} CF_{j2} X_j \leq K_2 + SF_1 (1 + r) \tag{15.10a}$$

In these expressions, SF_1 represents surplus funds in year 1 transferred to year 2. Since a negative SF_1 tantamounts to borrowing (which is not possible), we may add the constraint

$$SF_1 \leq 0 \tag{15.11}$$

to the above constraints.

Non-Financial Constraints Besides funds there may be other constraints pertaining to labour, material, and demand. These constraints can be readily incorporated in the linear programming model. An example of a material constraint is given below:

$$\sum m_j X_j \leq M \tag{15.12}$$

where m_j = material required for project j
X_j = proportion of project j accepted
M = total availability of material.

EXHIBIT 15.6

Optimal Tableau for LP Formulation of Lorie-Savage Nine-Project Problem

Basic Variable	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}	S_{11}	RHS
X_1	1.0											1.0									1.00
X_3			1.0											1.0							1.00
X_4				1.0											1.0						1.00
X_6		.455			5.91	1.0				–.015	.1818	–.364			–.273					–.273	.96969
X_7		1.068			–.114		1.0	.75		.023	–.023	–.205		–1.0	–.091					–.341	.04545
X_9									1.0											1.0	1.00
S_4		1.0											1.0								1.00
S_7					1.0											1.0					1.00
S_8		–.455			5.91					.015	.1818	.364		–1.0	.273		1.0			.273	.03030
S_9		–1.068			.114			–.75		–.023	.023	.205			.091			1.0		.341	.95454
S_{10}								1.0											1.0		1.00
Z	0	3.41	0	0	29.32	0	0	.50	0	.1364	1.864	6.77	0	5.0	10.45	0	0	0	0	3.95	70.273
	μ_1	μ_2	μ_3	μ_4	μ_5	μ_6	μ_7	μ_8	μ_9	ρ^*_1	ρ^*_2	γ_1	γ_2	γ_3	γ_4	γ_5	γ_6	γ_7	γ_8	γ_9	

Illustration

Consider a firm which is evaluating seven projects with the following characteristics:

Project	Net present value (NPV_j)	Cash outflow in period 1 (CF_{j1})	Cash outflow in period 2 (CF_{j2})
1	6	5	7
2	8	9	5
3	8	12	4
4	7	3	10
5	4	4	6
6	12	10	15
7	9	13	9

The budget available to the firm is limited to 35 in year 1 and 30 in year 2.

There are two additional constraints: power constraint and managerial constraint. The requirements and constraints applicable in this respect are shown below:

Project	Power requirement (E_j)	Managerial requirement (M_j)
1	2	6
2	4	5
3	5	7
4	3	2
5	4	4
6	7	8
7	6	3
	$\sum X_j E_j \leq 18$	$\sum X_j M_j \leq 20$

The linear programming formulation of the capital budgeting problem under various constraints mentioned above is as follows:

Maximise $6X_1 + 8X_2 + 8X_3 + 7X_4 + 4X_5 + 12X_6 + 9X_7$

Subject to

$$5X_1 + 9X_2 + 12X_3 + 3X_4 + 4X_5 + 10X_6 + 13X_7 + S_1 = 35 \quad \text{Funds constraint for year 1}$$

$$7X_1 + 5X_2 + 4X_3 + 10X_4 + 6X_5 + 15X_6 + 9X_7 + S_2 = 30 \quad \text{Funds constraint for year 2}$$

$$2X_1 + 4X_2 + 5X_3 + 3X_4 + 4X_5 + 7X_6 + 6X_7 + S_3 = 18 \quad \text{Power constraint}$$

$$6X_1 + 5X_2 + 7X_3 + 2X_4 + 4X_5 + 8X_6 + 3X_7 + S_4 = 20 \quad \text{Managerial constraint}$$

$$\left.\begin{array}{ll} X_1 + S_5 = 1 & X_5 + S_9 = 1 \\ X_2 + S_6 = 1 & X_6 + S_{10} = 1 \\ X_3 + S_7 = 1 & X_7 + S_{11} = 1 \end{array}\right] \text{Upper limits on project acceptance}$$

$$X_j \geq 0 \;\; (j = 1, 2, \ldots, 7)$$

$$S_i \geq 0 \;\; (i = 1, 2, \ldots, 11)$$

It may be noted that the approach taken in this formulation is similar to that represented in Eqs (15.6) through (15.8) above, except that 'slack variables' have been added to each inequality constraint to transform it into an equality constraint. Slack variables S_1 and S_2 represents the amounts unallocated in years 1 and 2; slack variable S_3 represents surplus power, slack variable S_4 represents surplus managerial capacity; slack variables S_5 through S_{11} represents the proportions of projects 1 through 7, respectively, which are not accepted.

INTEGER LINEAR PROGRAMMING MODEL

In his pioneering work on the application of mathematical programming to capital budgeting, Weingartner discussed the linear programming approach as well as the integer linear programming approach. The principal motivation for the use of integer linear programming approach are: (i) It overcomes the problem of partial projects which besets the linear programming model because it permits only 0 or 1 value for the decision variables. (ii) It is capable of handling virtually any kind of project interdependency.

Integer Linear Programming Model for Capital Rationing

The basic integer linear programming model for capital budgeting under capital rationing is as follows:

Maximise

$$\sum_{j=1}^{n} X_j \, NPV_j \tag{15.13}$$

Subject to

$$\sum_{j=1}^{n} CF_{jt} \, X_j \leq K_t \; (t = 0, 1, \ldots, m) \tag{15.14}$$

$$X_j = (0, 1) \tag{15.15}$$

It may be noted that the only difference between this integer linear programming model and the basic linear programming model discussed earlier is that the integer linear programming model ensures that a project is either completely accepted ($X_j = 1$) or completely rejected ($X_j = 0$).

Incorporating Project Interdependencies in the Model

By constraining the decision variables to 0 to 1, the integer linear programming model can handle almost any kind of project interdependency. To illustrate, let us see how the following kinds of project interdependencies are incorporated in the integer linear programming model:

- Mutual exclusiveness

- Contingency
- Complementariness

Mutual Exclusiveness If two or more projects are mutually exclusive, acceptance of any one project out of the set of mutually exclusive projects, automatically precludes the acceptance of all other projects in the set. From an economic point of view, mutually exclusive projects are substitutes for each other. Mutual exclusiveness is reflected in the integer programming model by the following constraint:

$$\sum_{j \in J} X_j \leq 1 \tag{15.16}$$

where J = the set of mutually exclusive projects under consideration
$j \in J$ = an expression which means that project j belongs to set J.

Constraint (15.16) means that the upper limit on the number of projects that can be selected from the set J is 1. This, of course, means that the firm may not select any project from the set J. If it is necessary to choose one project, but only one project, constraint (15.16) would become:

$$\sum_{j \in J} X_j = 1 \tag{15.17}$$

An important variant of the mutual exclusiveness condition is one in which the firm may delay a project for one or more years. Consider, for example, project X:

Time	Cash flow
0	– 10,000
1	3,000
2	3,000
3	3,000
4	3,000
5	3,000

The *NPV* of this project, given a cost of capital of 12 per cent, is 814. If the firm can delay this project by 1 or 2 years, two new projects X' and X'' can be defined:

Time	Cash flow of X′	Cash flow of X″
0	–	–
1	– 10,000	–
2	3,000	– 10,000
3	3,000	3,000
4	3,000	3,000
5	3,000	3,000
6	3,000	3,000
7	–	3,000

The *NPV*'s of projects X' and X'' to be included in the objective function are respectively 727 and 649. These values naturally differ from the *NPV* of X because of delays in cash flows associated with X' and X''. Since at best only one of the projects—X, X' and X'' —can be accepted, the following constraint is incorporated in the integer linear programming model:

$$X + X' + X'' \leq 1 \tag{15.18}$$

Contingency A contingency relationship between two or more projects implies that the acceptance of one project is contingent on the acceptance of some other project(s). For example, if project *B* cannot be accepted without accepting project *A*, we say that project *B* is contingent on project *A*. Put differently, project *A* is a prerequisite project for project *B*. Such a relationship is represented by the following constraint in the integer linear programming model.

$$X_B \leq X_A \tag{15.19}$$

It may be noted that as per constraint (15.19), project *B* can be accepted only when project *A* is accepted; project *A*, however, can be accepted independently.

A project may be contingent on not one but two (or even more) projects. Suppose, the acceptance of project *R* is contingent on the acceptance of projects *P* and *Q*. Such a contingency relationship is reflected in the following constraint.

$$2X_R \leq X_P + X_Q \tag{15.20}$$

Mutual Exclusiveness and Contingency Project dependency may reflect both mutual exclusiveness and contingency requirements. Some examples are described below:

1. *M* and *N* are mutually exclusive projects; a third project, *P*, is contingent on the acceptance of either *M* or *N*. This condition is reflected in the following constraints:

$$X_M + X_N \leq 1 \tag{15.21}$$

$$X_P \leq X_M + X_N \tag{15.22}$$

2. Out of the set of projects, *A*, *B*, *C* and *D* only three projects can be accepted. Further, for accepting project *E* at least two projects out of the above set should be accepted. This condition is reflected in the following constraints:

$$X_A + X_B + X_C + X_D \leq 3 \tag{15.23}$$

$$2X_E \leq X_A + X_B + X_C + X_D \tag{15.24}$$

Complementariness If undertaking a project influences favourably the cash flows of another project, the two projects are complementary projects. To illustrate how complementarity is reflected in the integer linear programming model, consider two projects *R* and *S*. Either of them can be accepted individually. However, if both are accepted together the following benefits will accrue: (i) The cost will reduce by 5 per cent. (ii) The net cash inflow will increase by 10 per cent. To reflect a complementary relationship of this kind, a composite project *RS* representing the combination of *R* and *S* is set up; the cash inflows of *RS* would be 10 per cent higher than the sum of the cash inflows of *R* and *S*. Further, since it is not possible to accept *R* and *S* as well as *RS*, because the latter is the composite project consisting of *R* and *S*, the following constraint is incorporated in the integer linear programming formulation:

$$X_R + X_S + X_{RS} \leq 1 \tag{15.25}$$

Integer Linear Programming Formulation: An Illustration

Consider the following 9 projects.

Project	Net present value (NPV_j)	Cash outflow in year 1 (CF_{j1})	Cash outflow in year 2 (CF_{j2})
1	44	50	48
2	30	40	22
3	20	10	40
4	25	36	5
5	35	25	60
6	24	43	15
7	42	40	0
8	28	33	14
9	60	75	48

The budget constraints for the two years are 150 and 180 respectively. The following project inter-dependencies obtain:

1. Projects 1 and 2 are mutually exclusive.
2. Out of the set of projects 4, 5, and 6 at least two must be accepted.
3. Project 9 cannot be accepted unless projects 4 and 6 are accepted.
4. Project 7 can be delayed by one year. Such a delay would not change the cash outflows but reduce *NPV* to 35.
5. Projects 8 and 9 are complementary. If the two are accepted together, the total cash outflows will be less by 8 per cent whereas the *NPV* will be more by 10 per cent.

Given the nature of the problem, in addition to the decision variables X_1 through X_9 for the original 9 projects, few additional decision variables are required as follows:

X_{10} is the decision variable to represent the delay of project 7 by one year.

X_{11} is the decision variable for the composite project which represents the combination of projects 8 and 9.

The integer linear programming formulation is as follows:

Maximise $\quad 44X_1 + 30X_2 + 20X_3 + 25X_4 + 35X_5 + 24X_6$

$\quad + 42X_7 + 28X_8 + 60X_9 + 35X_{10} + 96.8X_{11}$

Subject to

$$50X_1 + 40X_2 + 10X_3 + 36X_4 + 25X_5 + 43X_6$$
$$+ 40X_7 + 33X_8 + 75X_9 + 0X_{10} + 99.4X_{11} \le 150$$

$$48X_1 + 22X_2 + 40X_3 + 5X_4 + 60X_5 + 15X_6$$
$$+ 0X_7 + 14X_8 + 48X_9 + 40X_{10} + 47.88X_{11} + \le 180$$

$$X_1 + X_2 \le 1$$

$2X_9 \le X_4 +$ Xüx çx $_6$

$$X_7 + X_{10} \le 1$$

$$X_8 + X_9 + X_{11} \le 1$$

$$X_j = \{0, 1\}\ j = 1, 2, \ldots, 11$$

Evaluation

The principal strengths of the integer linear programming model, clearly demonstrated above, are:

1. It overcomes the problem of partial projects which besets the linear programming model.
2. It is capable of handling virtually any kind of project interdependency.

The major shortcomings of the integer linear programming model are:

1. The solution of an integer linear programming model takes considerably more time than the solution of the linear programming model. Pettway reported that for an integer linear programming model with 28 projects and 15 budget constraints, four out of six algorithms that he tried failed to reach an optimal solution in 5 minutes of CPU time on an IBM 360-65 system; the two algorithms which located the optimal solution took 118 seconds and 181 seconds. By contrast the solution time for the linear programming model of the same problem would take just one to two seconds. Further, the solution time for integer linear programming tends to grow exponentially as the number of projects increases because of the combinatorial nature of the problem. Other frustrating aspects of the integer linear programming model are: (i) The solution time may be highly variable—a small problem may take much more time than a large problem. (ii) Minor variations in the problem may lead to significant increase in solution times. (iii) No single solution algorithm works best for all types of integer linear programming problems.

2. Meaningful shadow prices are not available for the integer linear programming formulation. This happens because the integer linear programming model permits only discrete variation, not continuous variation, of the decision variables. In the integer linear programming model, constraints which are not binding in the optimal solution are assigned zero shadow prices though the objective function would decrease when the availability of resources, representing non-binding constraints, is diminished. Gomory and Baumol summarise the problem of shadow prices in integer linear programming as follows:[3]

> In integer programming, inputs clearly must be thought of as coming in indivisible units. For that reason we cannot speak, e.g., of the marginal profit contribution of a small change in input, i.e., we must deal with $\Delta R / \Delta X$ rather than dR/dX (as we do in *LP*) where ΔX is an indivisible unit of input X and R is total profit. But a dual-price represents dR/dX which may change over the range of a unit change in X, and hence it may well give an incorrect evaluation of the marginal revenue of input X.

GOAL PROGRAMMING MODEL

Throughout this text we assumed that the principal goal of financial management is to maximise the wealth of shareholders, which, under conditions of perfect capital market, can be realised by selecting the set of capital projects that maximise net present value.

However, in the real world, capital market imperfections (like capital rationing, differences in lending and borrowing rates, etc.) exist. Further, empirical observation show that managers pursue a multiple goal structure which includes, *inter alia*, the following:

- Growth in sales and market share
- Growth and stability of reported earnings

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[3] R.E. Gomory and W.J. Baumol, "Integer Programming and Pricing," *Econometrica* (September 1966), pp 521-550.

- Growth and stability of dividends

Therefore, a realistic representation of real life situations should reflect the multiple goals pursued by management. The goal programming approach, a kind of mathematical programming approach, provides a methodology for solving an optimisation problem that involves multiple goals. This approach, originally proposed by Charnes and Cooper in 1961, has been extended by Ijiri, Ignizio, and others.

To use the goal programming model, the decision maker must:

1. state an absolute priority order among his goals; and
2. provide a target value for each of his goals.

The goal programming methodology seeks to solve the programming problem by minimising the absolute deviations from the specific goals in order of the priority structure established. Goals at priority level one are sought to be optimised first. Only when this is done will the goals at priority level two will be considered; so on and so forth. At a given priority level, the relative importance of two or more goals is reflected in the weights assigned to them.

Goal Programming Format

In general, the goal programming format is as follows:

$$\text{Min} \quad Z = \left\{ P_1 \left[f_1 \left(a_1^+, a_1^- \right) \right] + P_2 \left[f_2 \left(a_2^+, a_2^- \right) \right] + \ldots \right.$$

$$\left. + P_m \left[f_m \left(d_m^+, d_m^- \right) \right] \right\} \tag{15.26}$$

Subject to

$$\sum a_{j1} X_j \leq C_1 \tag{15.27a}$$

$$\sum a_{j2} X_j \leq C_2 \tag{15.27b}$$

$$\sum a_{jk} X_j \leq C_k \tag{15.27k}$$

$$\vdots$$

$$\sum b_{j1} X_j + d_{1-}^{-} - d_1^+ = G_1 \tag{15.28a}$$

$$\sum b_{j2} X_j + d_2^{-} - - d_2^+ = G_2 \tag{15.28b}$$

$$\vdots$$

$$\sum b_{jm} X_j + d_m^- - d_m^+ = G_m \tag{15.28m}$$

$$X_j; d_i^+, d_i^- \geq 0 \tag{15.29}$$

The goal programming model is formulated in terms of three principal components: (i) the objective function, (ii) the economic constraints, and (iii) the goal constraints.

Objective Function The objective function, expressed as Eq. (15.26), seeks to minimise the weighted deviation from the target levels of various objectives in accordance with a priority structure. A formal representation of the objective function calls for specifying the following:

- The priority levels of goals
- The relative weights attached to each goal where there are two or more goals at the same priority level.

- The relevant deviational variables which should be minimised with respect to each goal.

Economic Constraints The economic constraints embodied in Eqs (15.27a) through (15.27k) represent resource limitations or restrictions emanating from the decision environment which cannot be violated. Hence they are also referred to as 'hard constraints'. The economic constraints in a goal programming model are similar to the constraints found in a linear programming model. Hence, such constraints require the usual slack or surplus variables.

Goal Constraints The goal constraints, embodied in Eqs (15.28a) through (15.28m) represent target levels of various goals that are pursued by the decision maker. Defined as strict equalities, goal constraints contain, in addition to an expression showing the impact of decision variables on goal attainment, two deviational variables denoted by d_1^+ and d_1^-. d_1^+ indicates that the desired level of goal *i* has been over-achieved; d_1^- indicates that the desired level of goal *i* has been under-achieved. When the desired goal level has been over-achieved d_1^+ is non-zero and d_1^- is zero; when the desired goal level has been under-achieved, d_1^+ is zero and d_1^- is non-zero; when the desired goal level is exactly achieved, both d_1^+ and d_1^- are zero. The deviational variables tie the goal constraints and the objective function. For each goal, the appropriate deviational variable(s) is (are) placed in the objective function.

Illustration

To illustrate the application of goal programming let us reconsider the example used in the context of our discussion on linear programming in which there were seven projects with the following characteristics:

Project	Net present value (NPV_j)	Cash outflow in period 1 (CF_{j1})	Cash outflow in period 2 (CF_{j2})	Power requirement (E_j)	Managerial requirement (M_j)
1	6	5	7	2	6
2	8	9	5	4	5
3	8	12	4	5	7
4	7	3	10	3	2
5	4	4	6	4	4
6	12	10	15	7	8
7	9	13	9	6	3
		$\sum X_j CF_{j1} \leq 35$	$\sum X_j CF_{j2} \leq 30$	$\sum X_j E_j \leq 18$	$\sum X_j M_j \leq 20$

The firm considering these projects now feels that in addition to the *NPV* objective, there are two other goals: net income objective and sales growth objective. The firm wants the net income from the set of projects selected to be 6 and 9 respectively in years 1 and 2. Further, the firm has set a sales growth target of 10 per cent for the first two years.

The contribution of the projects to net income and sales growth is shown below:

	Net Income		*Sales Growth*	
Project	**Year 1**	**Year 2**	**Year 1**	**Year 2**
1	1.0	1.4	0.010	0.020
2	2.1	1.6	0.015	0.010
3	1.8	2.5	0.018	0.025
4	1.2	3.0	0.020	0.025
5	1.0	0.8	0.015	0.010
6	2.5	1.2	0.030	0.025
7	1.4	1.3	0.025	0.020

The priorities assigned to various goals are as follows:

Priority 1 : Net income
Priority 2 : Sales growth
Priority 3 : *NPV*

At priority level one, net income for year one is weighted 2 times as the net income for year two; at priority level two, sales growth for year one is considered three times as important as the sales growth for year two.

The goal programming formulation of the above problem is given below.

Goal Function

$$\text{Min} \quad z = \left[P_1\,(2d_1^- + d_2^-) + P_2\,(3d_3^- + d_4^-) + P_3\,(d_5^- - d_5^+) \right]$$

Economic Constraints

$$5X_1 + 9X_2 + 12X_3 + 3X_4 + 4X_5 + 10X_6 + 13X_7 + S_1 = 35$$

Funds constraint for year 1

$$7X_1 + 5X_2 + 4X_3 + 10X_4 + 6X_5 + 15X_6 + 9X_7 + S_2 = 30$$

Funds constraint for year 2

$$2X_1 + 4X_2 + 5X_3 + 3X_4 + 4X_5 + 7X_6 + 6X_7 + S_3 = 18$$

Power constraint

$$6X_1 + 5X_2 + 7X_3 + 2X_4 + 4X_5 + 8X_6 + 3X_7 + S_4 = 20$$

Managerial constraint

$$X_1 + S_5 = 1 \qquad X_5 + S_9 = 1$$
$$X_2 + S_6 = 1 \qquad X_6 + S_{10} = 1$$
$$X_3 + S_7 = 1 \qquad X_7 + S_{11} = 1$$
$$X_4 + S_8 = 1$$

$$X_j \geq 0 \; (j = 1, 2, \ldots, 7)$$
$$S_i \geq 0 \; (i = 1, 2, \ldots, 11)$$

Goal Constraints

$$1.0X_1 + 2.1X_2 + 1.8X_3 + 1.2X_4 + 1.0X_5 + 2.5X_6 + 1.4X_7 + d_1^- - d_1^+ = 6$$

Net income for year 1

$$1.4X_1 + 1.6X_2 + 2.5X_3 + 3.0X_4 + 0.8X_5 + 1.2X_6 + 1.3X_7 + d_2^- - d_2^+ = 9$$

Net income for year 2

$$\begin{aligned} &0.01X_1 + 0.015X_2 + 0.018X_3 + 0.020X_4 + 0.015X_5 \\ &+ 0.03X_6 + 0.025X_7 + d_3^- - d_3^+ = 0.10 \quad \text{Sales growth for year 1} \end{aligned}$$

$$\begin{aligned} &0.02X_1 + 0.01X_2 + 0.025X_3 + 0.025X_4 + 0.01X_5 \\ &+ 0.025X_6 + 0.02X_7 + d_4^- - d_4^+ = 0.10 \quad \text{Sales growth for year 2} \end{aligned}$$

$$\begin{aligned} &6X_1 + 8X_2 + 8X_3 + 7X_4 + 4X_5 \\ &+ 12X_6 + 9X_7 + d_5^- - d_5^- = 50 \quad NPV \end{aligned}$$

It may be noted that in the goal constraint of *NPV*, it is arbitrarily set equal to 50. In the objective function, the *NPV* goal, set at priority level 3, is defined as

$$\text{Minimise} \quad (d_5^- - d_5^+)$$

This has the effect of striving for the maximum possible deviation from the target value—this means *NPV* is sought to be maximised.

Appropriate Objective Function

The decision maker may be interested in pursuing varied actions relative to different goals. The objective function term should reflect the character of the desired action. Here is a list of objective function terms corresponding to various desired actions.

Desired Action	**Objective Function Term**
• Attain a minimum level of some goal	Minimise d^-
• Do not exceed a given level of some goal	Minimise d^+
• Minimise the deviation from a specified goal level	Minimise $(d^+ + d^-)$
• Maximise the value achieved in relation to a given goal level	Minimise $(d^- - d^+)$
• Minimise the value achieved in relation to a given level	Minimise $(d^+ - d^-)$

SUMMARY

- Because of constraints like project dependence, capital rationing, and project indivisibility, investment projects cannot be viewed in isolation.
- Two projects are said to be economically dependent if the acceptance or rejection of one changes the cash flow stream of the other or affects the acceptance or rejection of the other. The types of economic dependency found among projects are: mutual exclusiveness, negative dependency, and positive dependency (complementariness).
- Capital rationing exists when funds available for investment are inadequate to undertake all projects which are otherwise acceptable. Capital rationing may arise because of an internal limitation or an external constraint.
- Capital projects are generally indivisible. This means that a capital project has to be accepted or rejected in total—a project cannot be accepted partially.

- Because of economic dependency, capital rationing, or project indivisibility, a need arises for comparing projects in order to accept some and reject others. Two approaches are available for this purpose: the method of ranking, and the method of mathematical programming.
- Fairly simple, the method of ranking consists of two steps: (i) Rank all projects in decreasing order according to their individual *NPV*'s, *IRR*'s, or *BCR*'s. (ii) Accept projects in that order until the capital budget is exhausted.
- The method of ranking, originally proposed by Joel Dean, is seriously impaired by two problems: (i) conflict in ranking as per discounted cash flow criteria, and (ii) project indivisibility.
- In a given set of projects, preference ranking tends to differ from one criterion to another. Ranking conflicts are traceable to differing assumptions about the rate of return at which intermediate cash flows are reinvested.
- The *NPV* method assumes that the intermediate cash flows are reinvested at a rate of return equal to the cost of capital of the firm. The *IRR* criterion assumes that cash flows are reinvested at a rate of return equal to or greater than the Fisherian rate of return. The *BCR* criterion assumes that intermediate funds are reinvested at a rate of return greater than the Fisherian rate of return.
- To select a set of projects, one may define all combinations of projects which are feasible, given the capital rationing constraint and project dependencies, and then choose that combination which has the highest *NPV* associated with it. This procedure may be called as the feasible combinations procedure.
- The feasible combinations procedure described above becomes increasingly cumbersome as the number of projects increases and as the number of years in the planning horizon increases. To cope with a problem of this kind, it is helpful to use mathematical programming models.
- A mathematical programming model is formulated in terms of two broad categories of equations: (i) the objective function, and (ii) constraint equations.
- Out of the wide variety of mathematical programming models, three types have greater applicability to the capital budgeting problem: linear programming model, integer linear programming model, and goal programming model.
- The most popular mathematical programming model, the linear programming model, assumes, *inter alia*, that the objective function and constraint equations are linear and the decision variables are continuous.
- The integer linear programming model, which assumes that the decision variables assume a value of 0 or 1, has two advantages: (i) It overcomes the problem of partial projects which besets the linear programming model. (ii) It is capable of handling virtually any kind of project interdependency like mutual exclusiveness, contingency, and complementarity.
- The goal programming model is a method for solving an optimisation problem with multiple goals. This method seeks to solve the programming problem of minimising the absolute deviations from the specific goals in order of the priority structure established.

QUESTIONS

1. Discuss different kinds of project dependency.
2. Discuss the sources of capital rationing.
3. Construct a set of five projects for which there is conflict in ranking as per *NPV*, *IRR*, and *BCR* criteria.
4. "The *NPV* method assumes that the intermediate cash flows are reinvested at a rate of return equal to the cost of capital of the firm". Demonstrate.
5. What is the Fisher's intersection point?
6. What reinvestment assumption underlies *IRR*?
7. What reinvestment assumption underlies *BCR*?
8. Describe the feasible combinations approach. Illustrate it with a numerical example.
9. What assumptions underlie the linear programming model?
10. Critically evaluate the integer linear programming model as a tool for capital budgeting.
11. Discuss the following in the context of a goal programming model: objective function, economic constraints, and goal constraints.

PROBLEMS

1. Consider a set of five projects:

Project	Investment outlay	Expected annual cash inflow	Project life
	Rs	Rs	years
M	50,000	18,000	10
N	100,000	50,000	4
O	120,000	30,000	8
P	150,000	40,000	16
Q	200,000	30,000	25

Rank the above five projects on the dimensions of *NPV*, *IRR*, and *BCR*.

2. Three projects, *X*, *Y*, and *Z* have the following cash flow streams:

	Net Cash Flow		
Year	X	Y	Z
	Rs	Rs	Rs
0	−30,000	−20,000	−20,000
1	8,000	6,000	5,000
2	8,000	6,000	5,000
3	8,000	5,000	5,000
4	8,000	5,000	5,000
5	6,000	5,000	5,000
6	6,000	4,000	2,000
7	6,000	4,000	10,000

Calculate the Fisherian rate of return over cost for projects $X - Y$, $X - Z$, and $Y - Z$.

3. Give two hypothetical 3-year projects for which NPV (at discount rate 10 per cent) and IRR give different ranking. Graph the two projects with cost of capital on the horizontal axis and NPV on the vertical axis.
4. Give two hypothetical 4-year projects for which the BCR and IRR criteria give different rankings. Assume that the discount rate is 12 per cent. Explain why the difference in ranking arises.
5. Five projects, *A*, *B*, *C*, *D*, and *E* are available to a company.

	A	*B*	*C*	*D*	*E*
Initial investment	Rs 20,000	50,000	75,000	100,000	150,000
Annual cash inflow	6,000	8,000	15,000	15,000	25,000
Life	5 years	10	8	12	7
Salvage value	5,000	–	–	15,000	50,000

Project *B* is a prerequisite for project *E* and projects *C* and *D* are mutually exclusive. Otherwise the projects are independent. If the cost of capital for the firm is 10 per cent, which projects should be chosen at the following budget levels: Rs 200,000 and Rs 250,000. Assume that the decision criterion is the net present value. Use the feasible combinations approach.

6. A firm is evaluating six investment opportunities:

Project (j)	Net present value (NPV_j)	Cash outflow in period 1 (CF_{j1})	Cash outflow in period 2 (CF_{j2})
	Rs	Rs	Rs
1	10,000	15,000	5,000
2	15,000	12,000	13,000
3	25,000	8,000	40,000
4	40,000	35,000	25,000
5	60,000	100,000	10,000
6	100,000	50,000	110,000

The budget available is limited to Rs 150,000 in year 1 and Rs 200,000 in year 2. Any amount not spent in year 1 can be transferred to year 2. The amount so transferred will earn a post-tax return of 8 per cent.

There are two additional constraints: working capital constraint and managerial constraint. The requirements and constraints applicable in this respect are

Project (j)	Working capital requirement (W_j)	Managerial requirement (M_j)
	Rs	
1	5,000	15
2	6,000	20
3	5,000	30
4	10,000	35
5	12,000	40
6	40,000	60
	$\sum X_j W_j \leq 60{,}000$	$\sum X_j M_j \leq 120$

Develop a linear programming formulation of the above capital budgeting problem.

7. Consider the following ten investment projects.

Project (j)	Net present value (NPV_j)	Cash outflow in period 1 (CF_{j1})	Cash outflow in period 2 (CF_{j2})
1	55	75	40
2	75	80	85
3	50	75	8
4	60	35	100
5	105	80	160
6	12	20	9
7	60	70	5
8	120	155	100
9	50	55	20
10	40	10	90

The budget constraints for years 1 and 2 are 400 and 350 respectively. The following project inter-dependencies exist:

(i) Projects 3 and 7 are mutually exclusive.
(ii) Out of the set of projects 5, 8, 9, and 10 at least two must be accepted.
(iii) Project 6 is a prerequisite for project 2.
(iv) Project 8 can be delayed by one year. Such a delay would shift the cash outflows by one year and reduce the *NPV* of project 8 by 20.
(v) Projects 4 and 5 are complementary. If the two are accepted together, the total cash outflows will be less by 5 per cent whereas the *NPV* will be more by 8 per cent.
(vi) If project 8 is accepted, project 9 must also be accepted.

Develop the integer linear programming formulation of the above problem.

8. Delta International is considering seven projects with the following characteristics.

		Contribution to Net Income			*Contribution to Sales Growth (percentage)*			
Project	**Initial outlay**	**Year 1**	**Year 2**	**Year 3**	**Year 1**	**Year 2**	**Year 3**	***NPV***
1	12	1.2	1.1	1.6	1.0	1.5	1.8	4
2	14	1.6	1.2	1.5	1.2	1.0	1.2	5
3	15	0.6	1.2	2.0	0.5	1.2	2.5	6
4	16	1.5	1.6	1.8	1.8	2.0	2.2	8
5	11	0.5	1.2	1.5	0.6	1.4	1.8	4
6	23	0.9	2.5	4.0	1.0	3.0	3.5	9
7	20	1.8	2.0	2.2	2.0	3.0	3.5	7

The capital budget constraint is 65. The goals sought by management are as follows: (i) maximisation of *NPV*, (ii) contribution to net income of 6.0, 8.0, and 10.0 in years 1, 2, and 3, and (iii) contribution to sales growth of 6, 8, and 10 per cent in years 1, 2, and 3. The priorities assigned to various goals are as follows:

Priority 1 : Net income
Priority 2 : Sales growth
Priority 3 : *NPV*

At priority level 1, the relative weights attached to the net income of years 1, 2, and 3 are 3, 2, and, 1 respectively. At priority level 2, the relative weights attached to the contribution to sales growth of years 1, 2, and 3 are 4, 2, and 1 respectively.

Formulate the above problem as a goal programming problem.

9. The Premier Company draws a 2-year capital budget. The amount available for the next two years is Rs 2.5 million, Rs 2 million is on hand now and Rs 0.5 million will be available after a year. Some projects can be undertaken now, some after a year. The *BCR* of the projects calculated at the point of investment is as follows:

(in million)

Projects Available Now			*Projects Available After a Year*		
Number	**Initial investment**	***BCR***	**Number**	**Initial investment**	***BCR***
1	0.8	1.08	6	0.5	1.03
2	0.2	1.35	7	0.4	1.21
3	0.4	1.20	8	0.6	1.17
4	0.3	1.03	9	0.3	1.01
5	0.2	0.98			

The tax rate of the company is 60 per cent and its post-tax cost of capital is 10 per cent. One year bank deposit carries 8 per cent rate of interest. Draw the 2-year capital budget for the company.

16

Options and Flexibility

The standard discounted cash flow analysis calls for evaluating a project on the basis of its cash flows over its economic life. Such an evaluation, however, does not capture the value of options embedded in the project. When a firm undertakes a project it is likely to enjoy certain options in future. It can expand its commitments; it can put the facilities to some other use; it may truncate or even abandon the project. Valuable as these options are, they should not be ignored in project evaluation. This means that the evaluation exercise must be expanded beyond the standard discounted cash flow analysis so that it covers the valuation of options as well.

This chapter discusses the insights provided by the option pricing theory, developed primarily for valuing security options, and shows how the same may be applied for valuing options embedded in capital projects. It is organised into eight sections as follows:

- Terminology
- Options and their payoffs just before expiration
- Factors determining option values
- Binomial model for option valuation
- Black and Scholes model
- Value of a piece of vacant land
- Value of an option to make a follow on investment
- Judgemental assessment of options

TERMINOLOGY

The key terms and phrases employed in discussing options are as follows:

Option holder and option writer The option holder is the buyer of the option and the option writer is the seller of the option.

Exercise price or striking price The price at which the option holder can buy and/or sell the underlying asset is called the exercise price or striking price.

Expiration date or maturity date The date when the option expires or matures is referred to as the expiration date or maturity date. After the expiration date, the option is worthless.

Exercising the option The act of buying or selling the underlying asset as per the option contract.

European and American options A European option can be exercised only on the expiration date whereas an American option can be exercised on or before the expiration date.

OPTIONS AND THEIR PAYOFFS JUST BEFORE EXPIRATION

There are two basic types of options, call options and put options. This section looks at the features of these options and their payoffs just before expiration, from the point of view of the option holder as well as the option writer. In addition, it discusses combination options.

Call Option

The most common type of option, the call option gives the option holder the right to buy an asset at a fixed price on or before a certain date. While there is no restriction on the kind of asset, the most popular type of call option is the option on stocks. For example, investors can buy call options on General Motors stock (and many other stocks) on the Chicago Board of Option Exchange. A typical call option on General Motors stock entitles the investor to buy 100 shares of General Motors on or before say July 15, 199X at an exercise price of $Y. Such an option is valuable if there is some likelihood that the price of the common (equity) stock of General Motors will rise above $Y on or before July 15, 199X. (To provide protection to the option holder, the option contract generally specifies that the exercise price and the number of shares will be adjusted for stock splits and stock dividends. For example, if the General Motors stock splits 4 to 1, the option contract will be for 400 shares at an exercise price of $Y/4. Of course, no adjustment is made for cash dividends. Remember that the holder of a call option is not entitled to receive cash dividends.)

Payoff of a Call Option

What is the payoff of a European call option?[1] To answer this question let us look at the possible payoffs of the call option just before expiration. The payoff of the call option (C) just before expiration depends on the relationship between the stock price (S_1) and the exercise price (E). Formally

$$C = S_1 - E \text{ if } S_1 > E \tag{16.1}$$

$$C = 0 \text{ if } S_1 < E \tag{16.2}$$

This means that $C = \text{Max}(S_1 - E, 0)$. Exhibit 16.1 shows graphically the value of call option. When $S_1 < E$, the call is said to be "out of money" and is worthless. When $S_1 > E$, the call is said to be "in the money" and its value is $S_1 - E$.

Put Option

The opposite of a call option is a put option. While the call option gives the holder the right to buy a stock at a fixed price, the put option gives the holder the right to sell a stock at a fixed price. For example, a put option on the IBM stock may give its holder the right to sell 100 shares of IBM on or before July 15, 199X at a price of $ Y per share. Such an option is valuable if there is some possibility that the price of IBM stock will fall below \$ Y per share on or before July 15, 199X.

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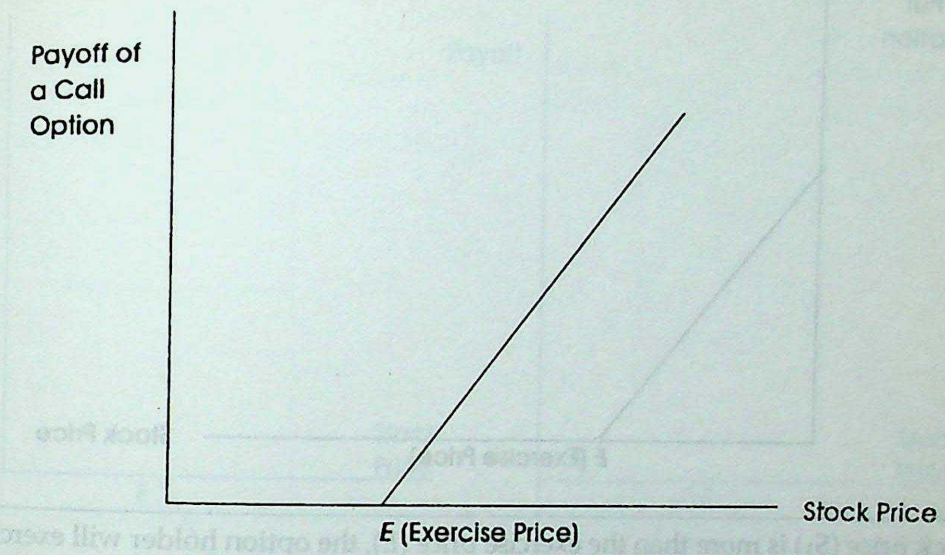
[1] Recall that such an option can be exercised only on the expiration date, not before.

EXHIBIT 16.1

Payoff of a Call Option



Payoff of a Put Option

The payoff of a put option just before expiration depends on the relationship between the exercise price (E) and the price of the underlying stock (S_1). If $S_1 < E$, the put option has a value of $S_1 - E$ and it is said to be "in the money". On the other hand if $S_1 > E$, the put option is worthless and is said to be "out of money". Thus the payoff of a put option just before expiration is :

	If $S_1 < E$	*If* $S_1 \geq E$
Value of the put option	$E - S_1$	0

Put differently, just before expiration the payoff of a put option is Max $(E - S_1, 0)$. Exhibit 16.2 plots the relationship between the value of the underlying stock and the pay off of the put option.

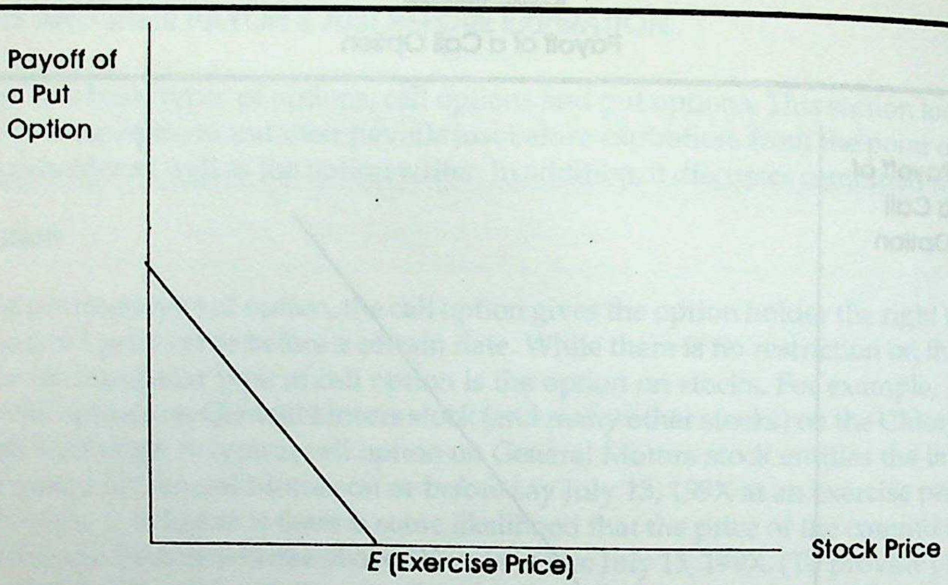
Seller's Position

We discussed the payoffs of call and put options from the point of view of the option buyer (or holder). Let us now look at the options from the point of view of the option writer (or seller).

A writer of a call option collects the option premium from the buyer (holder) of the option. In return, he is obliged to deliver the shares, should the option buyer exercise the option. If the stock price (S_1) is less than the exercise price (E) on the expiration date, the option holder will not exercise the option. In this case, the option writer's liability is nil. On the other hand

EXHIBIT 16.2

Payoff of a Put Option



if the stock price (S_1) is more than the exercise price (E), the option holder will exercise the option. Hence the option writer loses $S_1 - E$.

What is the payoff from the point of view of the seller (or writer) of a put option? If the price of the stock (S_1) is equal to or more than the exercise price (E), the holder of the put option will not exercise the option. Hence the option writer's liability is nil. On the other hand if $S_1 < E$, the holder of the put option will exercise the option. Hence the option writer loses $E - S_1$. The payoffs for a "selling a call" and "selling a put" from the seller's point of view are plotted in Exhibit 16.3.

Combinations

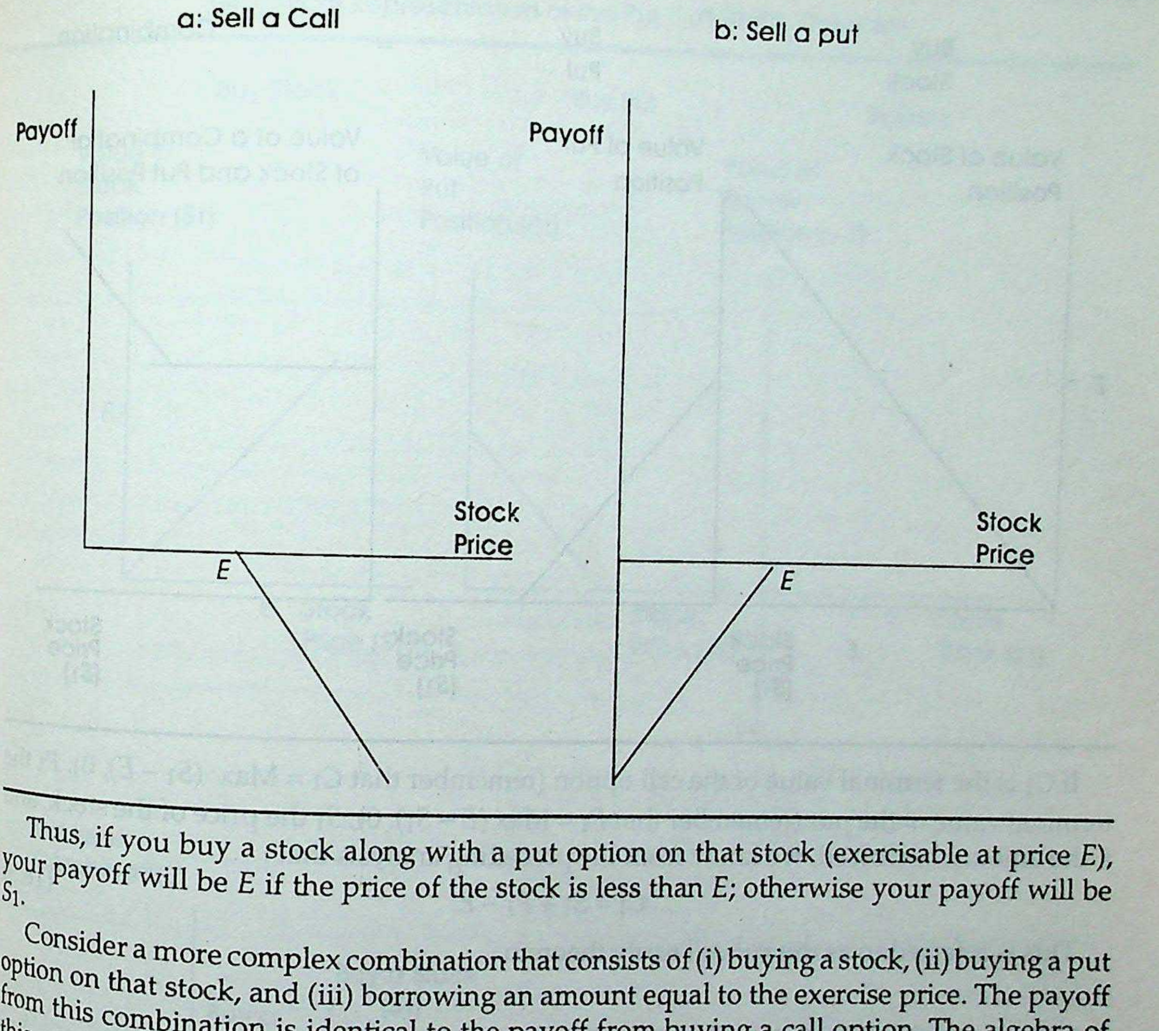
Puts and calls represent basic options. They serve as building blocks for developing more complex options. Exhibit 16.4 shows the payoff for a combination of (i) buying a stock and (ii) buying a put option on the stock.

The algebra corresponding to this combination is as follows:

	Payoffs Just Before Expiration Date	
	If $S_1 < E$	*If $S_1 \geq E$*
(1) Put Option +	$E - S_1$	0
(2) Equity Stock	S_1	S_1
= Combination	E	S_1

EXHIBIT 16.3

Payoffs to the Seller of Options



a: Sell a Call

b: Sell a put

Thus, if you buy a stock along with a put option on that stock (exercisable at price E), your payoff will be E if the price of the stock is less than E; otherwise your payoff will be S_1.

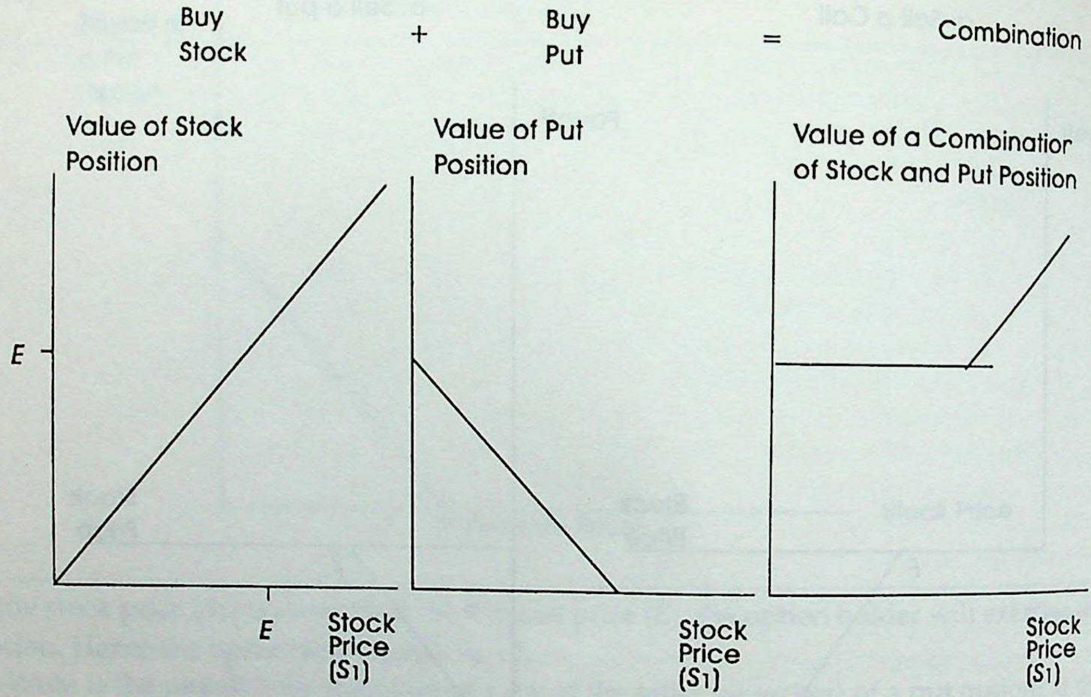
Consider a more complex combination that consists of (i) buying a stock, (ii) buying a put option on that stock, and (iii) borrowing an amount equal to the exercise price. The payoff from this combination is identical to the payoff from buying a call option. The algebra of this equivalence is shown below:

	Payoff Just Before Expiration Date	
	If $S_1 < E$	*If $S_1 \geq E$*
(1) Buy the equity stock	S_1	S_1
(2) Buy a put option	$E - S_1$	0
(3) Borrow an amount equal to the exercise price	$-E$	$-E$
(1) + (2) + (3) = Buy a call option	0	$S_1 - E$

The payoffs from the individual components and the combination are shown in Exhibit 16.5.

EXHIBIT 16.4

Payoffs of a Combination of Buying Equity Stock and Put Option



If C_1 is the terminal value of the call option (remember that $C_1 = \text{Max } (S_1 - E), 0)$, P_1 the terminal value of the put (remember that $P_1 = \text{Max } (E - S_1), 0)$, S_1 the price of the stock, and E the amount borrowed, we know from the preceding analysis that :

$$C_1 = S_1 + P_1 - E \tag{16.3}$$

This is referred to as the *put-call parity* theorem.

FACTORS DETERMINING OPTION VALUES

In the previous section, we looked at the payoffs of options just before the expiration date. Now we determine the present value of options.

Boundaries

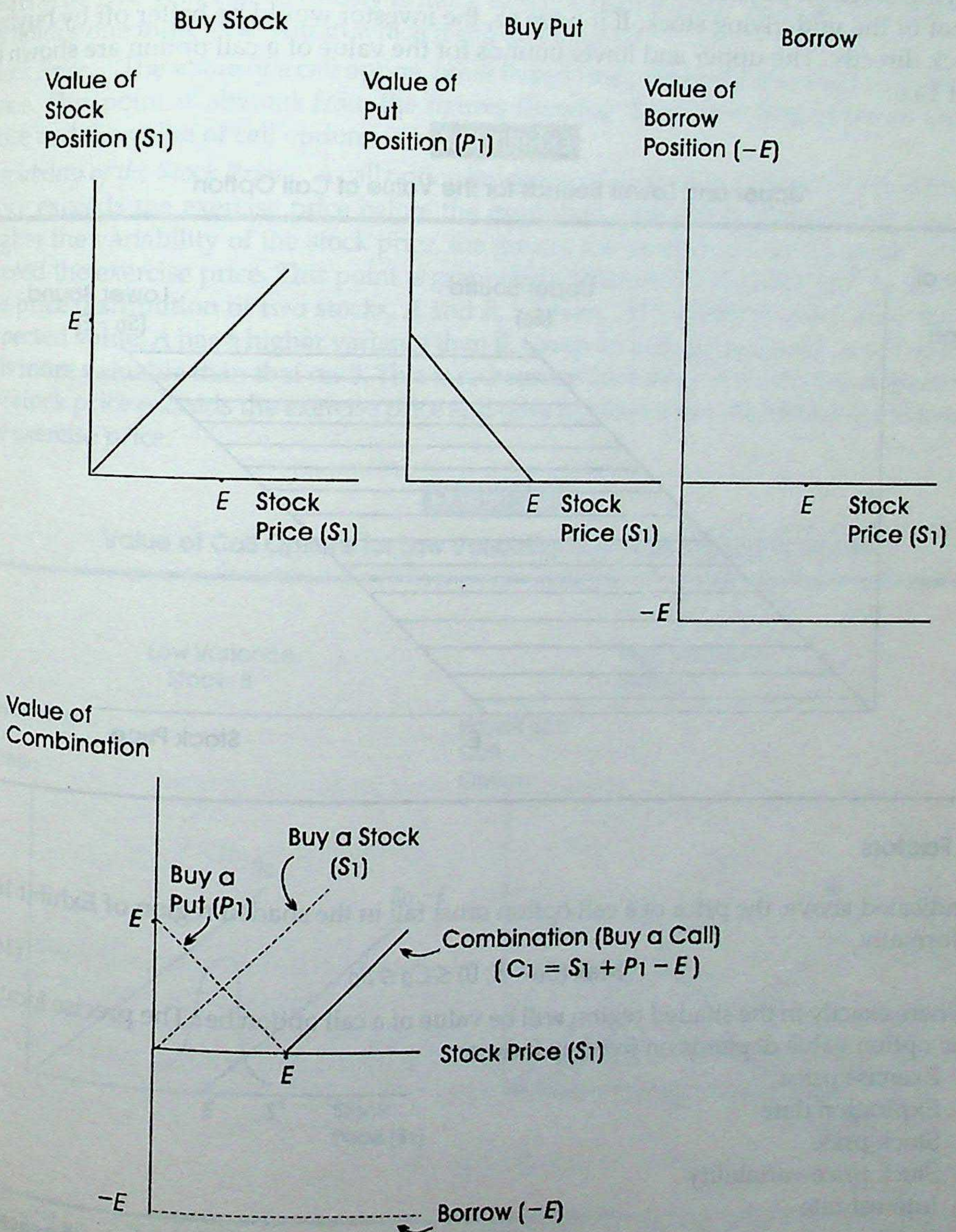
Before we identify the factors determining option values, it is helpful to specify the boundaries within which the value of an option falls.

The minimum value at which a call option sells before the expiration date, say, at time zero, is Max $(0, S_0 - E)$. This means that C_0, the value of a call option, can never fall below zero (this happens when $S_0 < E$). Also, it means that the value of a call option cannot fall below $S_0 - E$ (this happens when $S_0 > E$). To see why this is so, consider a call option with

$E = 150$, $S_0 = 250$, and $C_0 = 75$. In this case it pays an investor to buy the call option for 75, exercise it for 150, and finally sell the stock for 250. By doing so he earns a profit of:

EXHIBIT 16.5

Graphical Representation of the Put Call Parity Theorem


Buy Stock
Value of Stock Position (S_1)
E
E
Stock Price (S_1)
Buy Put
Value of Put Position (P_1)
E
Stock Price (S_1)
Borrow
Value of Borrow Position ($-E$)
E
Stock Price (S_1)
$-E$
Value of Combination
Buy a Stock (S_1)
Buy a Put (P_1)
E
Combination (Buy a Call)
($C_1 = S_1 + P_1 - E$)
Stock Price (S_1)
E
$-E$
Borrow ($-E$)

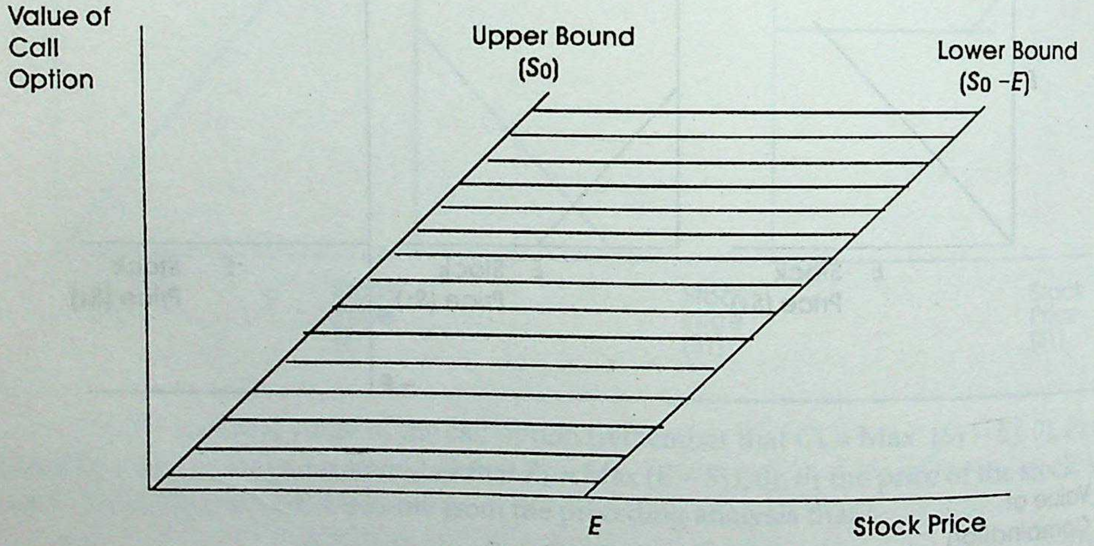
$$S_0 - (C_0 + E) = 250 - (75 + 150) = 25$$

This profit, reflecting arbitrage profit, comes without incurring any risk or cost. Such a profit cannot occur in a well functioning financial market. Hence, in such a market C_0 cannot sell for less than $S_0 - E$.

What is the upper limit for the option price? A call option entitles the holder to buy the underlying stock on payment of a certain exercise price. Hence its value cannot be greater than that of the underlying stock. If it were so, the investor would be better off by buying the stock directly. The upper and lower bounds for the value of a call option are shown in Exhibit 16.6.

EXHIBIT 16.6

Upper and Lower Bounds for the Value of Call Option



Key Factors

As indicated above, the price of a call option must fall in the shaded region of Exhibit 16.6. Put formally,

$$\text{Max}\,(S_0 - E, 0) \leq C_0 \leq S_0 \tag{16.4}$$

Where exactly in the shaded region will be value of a call option be? The precise location of the option value depends on five key factors:

- Exercise price
- Expiration date
- Stock price
- Stock price variability
- Interest rate

Exercise Price By now it is obvious that, other things being constant, the higher the exercise price the lower the value of the call option. Remember that the value of a call option can never be negative, regardless of how high the exercise price is set. Further it has a positive value if there is some possibility that the stock price will be higher than the exercise price before the expiration date.

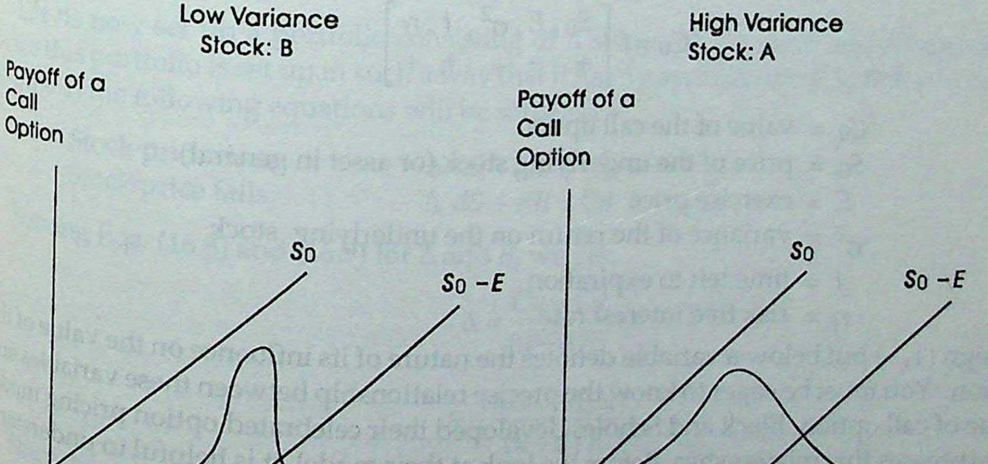
Expiration Date Other things being equal, the longer the time to expiration date, the more valuable the call option. Consider two American calls with maturities of one year and two years. The two year call obviously is more valuable than the one year call because it gives its holder one more year within which it can be exercised.

Stock Price The value of a call option, other things being constant, increases with the stock price. This point is obvious from the figures showing the relationship between the stock price and the value of call option.

Variability of the Stock Price A call option has value when there is a possibility that the stock price exceeds the exercise price before the expiration date. Other things being equal, the higher the variability of the stock price, the greater the likelihood that the stock price will exceed the exercise price. This point is graphically illustrated in Exhibit 16.7. In this figure the price distribution of two stocks, *A* and *B*, is given. While both *A* and *B* have the same expected value, *A* has a higher variance than *B*. Given an exercise price of *E*, a call option on *A* is more valuable than that on *B*. This is so because the holder of a call option gains when the stock price exceeds the exercise price and does not lose when the stock price is less than the exercise price.

EXHIBIT 16.7

Value of Call Options for Low Variability and High Variability Stocks



So fundamental is this point that it calls for another illustration. Consider the probability distribution of the price of two stocks, *P* and *Q*, just before the call option (with an exercise price of 80) on them expires.

P		Q	
Price	**Probability**	**Price**	**Probability**
60	0.5	50	0.5
80	0.5	90	0.5

While the expected price of stock *Q* is same as that of stock *P*, the variance of *Q* is higher than that of *P*. The call option (exercise price: 80) on stock *P* is worthless as there is no likelihood that the price of stock *P* will exceed 80. However, the call option on stock *Q* is valuable because there is a distinct possibility that the stock price will exceed the exercise price.

Remember that there is a basic difference between holding a stock and holding a call option on the stock. If you are a risk-averse investor you try to avoid buying a high variance stock, as it exposes you to the possibility of negative returns. However, you will like to buy a call option on that stock because you receive the profit from the right tail of the profitability distribution, while avoiding the loss on the left tail. Thus, regardless of your risk disposition, you will find a high variance in the underlying stock desirable.

Interest Rate When you buy a call option you do not pay the exercise price until you decide to exercise the call option. Put differently, the payment, if any, is made in future. The higher the interest rate, the greater the benefit will be from delayed payment and vice versa. So the value of a call option is positively related to the interest rate.

Functional Relationship

The manner in which the five variables discussed above influence the value of a call option is shown in the following relationship:

$$C_0 = f\begin{bmatrix} S_0, E, \sigma^2, t, r_f \\ + \quad - \quad + \quad + \quad + \end{bmatrix} \tag{16.5}$$

where C_0 = value of the call option
S_0 = price of the underlying stock (or asset in general)
E = exercise price
σ^2 = variance of the return on the underlying stock
t = time left to expiration
r_f = risk free interest rate

The sign (+, –) put below a variable denotes the nature of its influence on the value of the call option. You must be eager to know the precise relationship between these variables and the value of call option. Black and Scholes developed their celebrated option pricing model which expresses this relationship. Before we look at their model, it is helpful to understand the two-state or binomial option valuation model.

BINOMIAL MODEL FOR OPTION VALUATION

The standard *DCF* (Discounted Cash Flow) procedure involves two steps, viz., estimation of expected future cash flows and discounting of these cash flows using an appropriate cost of capital. There are problems in applying this procedure to option valuation. While it is difficult (though feasible) to estimate expected cash flows, it is impossible to determine the opportunity cost of capital because the risk of an option is virtually indeterminate as it changes every time the stock price varies.

Since options cannot be valued by the standard DCF method, financial economists struggled to develop a rigorous method for valuing options for many years. Finally, a real breakthrough occurred when Fisher Black and Myron Scholes[2] published their famous model in 1973. The basic idea underlying their model is to set up a portfolio which imitates the call option in its payoff. The cost of such a portfolio, which is readily observed, must represent the value of the call option.

The key insight underlying the Black and Scholes model may be illustrated through a single-period binomial (or two-state) model. The following assumptions may be employed to develop this model.

- The stock, currently selling for S, can take two possible values next year, uS or dS $(uS > dS)$
- An amount of B can be borrowed or lent at a rate of r. The interest factor $(1 + r)$ may be represented, for the sake of simplicity, as R.
- The value of R is greater than d but smaller than u $(d < R < u)$. This condition ensures that there is no risk-free arbitrage opportunity.
- The exercise price is E.

The value of the call option, just before expiration, if the stock price goes up to uS, is

$$Cu = \text{Max}\,(uS - E, 0) \tag{16.6}$$

Likewise, the value of the call option, just before expiration, if the stock price goes down to dS is

$$Cd = \text{Max}\,(dS - E, 0) \tag{16.7}$$

Let us now set up a portfolio consisting of Δ shares of the stock and B rupees of debt. Since this portfolio is set up in such a way that it has a payoff identical to that of a call option at time 1, the following equations will be satisfied:

Stock price rises: $$\Delta\ uS + RB = Cu \tag{16.8}$$

Stock price falls: $$\Delta\ dS + RB = Cd \tag{16.9}$$

Solving Eqs. (16.8) and (16.9) for Δ and B, we get:

$$\Delta = \frac{Cu - Cd}{(u - d)\,S} \tag{16.10}$$

$$B = \frac{uCd - dCu}{(u - d)\,R} \tag{16.11}$$

Since the portfolio (consisting of Δ shares and B debt) has the same payoff as that of a call option, the value of the call option is

$$C = \Delta\ S + B \tag{16.12}$$

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[2] Fisher Black and Myron Scholes "The Pricing of Options and Corporate Liabilities," *Journal of Political Economy*, Vol 81, (May-June 1973), pp 637-54.

Illustration

To illustrate the application of the binomial model consider the following data:

$$S = 200, u = 1.4, d = 0.9$$

$$E = 220, r = 0.15, R = 1.15$$

$$Cu = \text{Max}\,(uS - E, 0) = \text{Max}\,(280 - 220, 0) = 60$$

$$Cd = \text{Max}\,(dS - E, 0) = \text{Max}\,(180 - 220, 0) = 0$$

Given the above data, we can get the values of Δ and B by using Eqs. (16.10) and (16.11).

$$\Delta = \frac{Cu - Cd}{(u - d)s} = \frac{60}{0.5(200)} = 0.6$$

$$B = \frac{uCd - dCu}{(u - d)\,R} = \frac{-0.9(60)}{0.5(1.15)} = -93.91$$

(A negative value for B means that funds are borrowed.)

Thus, the portfolio consists of 0.6 of a share plus a borrowing of 93.91 (entailing a repayment of 93.91 (1.15) = 108 after one year) mimics the call option. The identity of the payoffs of the portfolio and the call option is shown below:

	Portfolio		**Call option**
When u occurs	$1.4 \times 200 \times 0.6 - 108$	$= 60$	$Cu = 60$
When d occurs	$0.9 \times 200 \times 0.6 - 108$	$= 0$	$Cd = 0$

Given the equivalence of the call option and the portfolio, the value of the call option is:

$$C = \Delta\ S + B = 0.6 \times 200 - 93.91 = 26.09$$

Note that we established the value of the call option without any idea about the probability that the stock would go up or come down. An optimistic investor may think that the probability of an up move is high whereas a pessimistic investor may think that it is low. Yet the two will agree that the value of the call option is 26.09. Why? The answer lies in the fact that the current stock price of 200 already incorporates the views of the optimists as well as the pessimists. And the option value, in turn, depends on the stock price.

BLACK AND SCHOLES MODEL

The above analysis was based on the assumption that there were two possible values for the stock price at the end of one year. If we assume that there are two possible stock prices at the end of each 6-month period, the number of possible end-of-year prices increases. As the period is further shortened (from 6-months to 3-months or 1 month), we get more frequent changes in stock price and a wider range of possible end-of-year prices. Eventually, we would reach a situation where prices change more or less continuously, leading to a continuum of possible prices at the end of the year. Theoretically, even for this situation we could set up a portfolio which has a payoff identical to that of a call option. However, the composition of this portfolio will have to be changed continuously as the year progresses.

Calculating the value of such a portfolio and through that the value of the call option in such a situation appears to be an unwieldy task, but Black and Scholes developed a formula that does precisely that. Their formula is:

$$C_0 = S_0\,N(d_1) - \frac{E}{e^{rt}}\,N(d_2) \tag{16.13}$$

where
C_0 = equilibrium value of a call option now
S_0 = price of the stock now
E = exercise price
e = base of natural logarithm
r = continuously compounded risk-free annual interest rate
t = length of time in years to the expiration date
$N(d)$ = value of the cumulative normal density function

$$d_1 = \frac{l_n\left(\frac{S_0}{E}\right) + \left(r + \frac{1}{2}\sigma^2\right)t}{\sqrt{\sigma^2 t}} \tag{16.14}$$

$$d_2 = \frac{l_n\left(\frac{S_0}{E}\right) + \left(r - \frac{1}{2}\sigma^2\right)t}{\sqrt{\sigma^2 t}} \tag{16.15}$$

where
l_n = natural logarithm
σ^2 = standard deviation of the continuously compounded annual rate of return on the stock

Though one of the most complicated formulae in finance, it is one of the most practical. The formula has great appeal because four of the parameters, namely, S_0, E, r, and t are observable. Only one of the parameters, namely, σ^2, has to be estimated. Note that the value of a call option is affected by neither the risk aversion of the investor nor the expected return on the stock.

Assumptions

You may have guessed by now that the Black and Scholes model, like other important models in economics and finance, is based on a set of simplifying assumption. Yes, you are right. The assumptions underlying the Black and Scholes model are as follows:

- The call option is the European option
- The stock price is continuous and is distributed lognormally
- There are no transaction costs and taxes
- There are no restrictions on or penalties for short selling
- The stock pays no dividend
- The risk-free interest rate is known and constant.

These assumptions may appear very severe. However when some of them do not hold, a variant of the Black and Scholes model applies. Further, empirical studies indicate that the Black and Scholes model applies to American options as well.

Example

The following data is available for Personal Products Company (PPC), a company that is not expected to pay dividend for a year.

$$S_0 = 60$$

$$\begin{aligned} E &= 56 \\ r &= 0.14 \\ t &= 0.5 \\ \sigma &= 0.3 \\ \sigma^2 &= 0.09 \end{aligned}$$

What is the value of the call option as per the Black and Scholes model? To apply the Black and Scholes model we have to first determine $N(d_1)$ and $N(d_2)$.

$$d_1 = \frac{l_n\left(\frac{S_0}{E}\right)+\left[r+\frac{1}{2}\sigma^2\right]t}{\sigma\sqrt{t}}$$

$$= \frac{l_n\left(\frac{60}{56}\right)+\left[0.14+\frac{1}{2}\times 0.09\right]0.5}{0.30\sqrt{0.5}}$$

$$= \frac{0.068993+0.0925}{0.2121} = \frac{0.161493}{0.2121} = 0.761$$

$$d_2 = \frac{l_n\left(\frac{S_0}{E}\right)+\left[r-\frac{1}{2}\sigma^2\right]t}{\sigma\sqrt{t}}$$

$$= \frac{0.06993+[0.14-\frac{1}{2}\times 0.09]\,0.05}{0.30\sqrt{0.5}} = 0.554$$

$N(d_1)$ and $N(d_2)$ represent the probabilities that a random variable that has a standardized normal distribution will assume values less than d_1 and d_2. To calculate $N(d_1)$ and $N(d_2)$ we shall consult Table A.5 (given in Appendix A at the end of the book) showing the cumulative probabilities of the standard normal distribution function.

$$\begin{aligned} N(d_1) &= N(0.761) = 0.7762 \\ N(d_2) &= N(0.554) = 0.7102 \end{aligned}$$

The value of the call option is :

$$C_0 = S_0\,N(d_1) - \frac{E}{e^{rt}}\,N(d_2)$$

$$\begin{aligned} C_0 &= 60\times 0.7762 - \frac{56}{1.0725}\times 0.7102 \\ &= 46.572 - 37.083 \\ &= 9.489 \end{aligned}$$

Using the Black-Scholes Model

The Black-Scholes option valuation model may appear very abstruse and divorced from the real world. Yet, option traders use it routinely to guide their trading decisions. They generally use programmed calculators or a set of tables.

The procedure employed to calculate the value of a call option with the help of the tables is as follows:

1. Find the product of the standard deviation of the continuously compounded asset value change and the square root of the time left to the option's expiration. For example, if there is a 1-year call option on the stock of Pioneer Company and the standard deviation of the continuously compounded stock price change is 30 per cent per year, the product is:

$$\text{Standard deviation} \times \sqrt{\text{Time}} = 0.30 \times \sqrt{1} = 0.30$$

2. Calculate the ratio of the current value of the asset to the present value of the exercise price. For example, suppose that the stock of Pioneer Company sells for Rs 120, that the exercise price is Rs 125, and that the effective interest rate is 15.03 per cent. Then the ratio is:

$$\frac{\text{Stock price}}{\text{Present value of exercise price}} = 120/\frac{125}{1.1503} = 1.10$$

3. Consult Table A.6 (given in Appendix A at the end of the book) and find the value (which represents the percentage relationship between the value of the call option and the stock price) corresponding to the numbers obtained in steps 1 and 2. This value for the example of Pioneer Company is 16.5 per cent. Hence, the value of the call option is :

$$0.165 \times 120 = 19.8$$

4. Calculate the value of the put option using the following relationship:

$$\text{Value of put option} = \text{Value of call option} + \text{Present value of exercise price} - \text{Stock price}$$

For the Pioneer Company's example, the value of the put option is:

$$19.8 + 108.7 - 120 = 8.5$$

VALUE OF A PIECE OF VACANT LAND

There is a piece of vacant land in a residential area. Its most profitable use is for an apartment building. It is possible to build either an eight or twelve unit building. How should the land be valued? The traditional approach suggests that the value of the land is equal to the net present value of the cash flows (excluding the cost of land) of the superior alternative. For example, if the net present value of the cash flows (excluding the cost of land) of the 8 unit building is higher it represents the value of land.

The traditional approach gives a correct estimate of the value of land provided it has to be developed immediately. The vacant land, however, typically partakes the characteristics of an option because of the possibility of postponement. If the owner of the land can delay construction by a year, he enjoys the option of choosing between the two alternatives a year hence. This option has value if the most profitable alternative next year is likely to be different from the most profitable alternative this year.

For illustrating these ideas, consider the following data:

- Current interest rate : 12 per cent
- Current value of an apartment : Rs 0.6 million
- Value of an apartment a year from now

(a) Rs 0.75 million under favourable conditions
(b) Rs 0.54 million under unfavourable conditions

– Construction costs (this year as well as the next)
(a) For an 8 unit building : Rs 3.6 million
(b) For a 12 unit building : Rs 6.2 million

If the land is developed immediately its value is the higher of the following two:

– 8 unit building	:	Value of apartments	: Rs 4.8 million
		Construction costs	: Rs 3.6 million
		Net value	: Rs 1.2 million
– 12 unit building	:	Value of apartments	: Rs 7.2 million
		Construction costs	: Rs 6.2 million
		Net value	: Rs 1.0 million

Hence the value of land if developed currently is Rs 1.2 million.

Now consider what happens if construction is postponed to next year.

- If the apartments are worth Rs 0.75 million next year, it is advisable to construct a 12 unit building generating a net value of Rs 2.8 million [12(0.75) – 6.2]
- If the apartments are worth Rs 0.54 million next year, it is advisable to construct an 8 unit building generating a net value of Rs 0.72 million [8(0.54) – 3.6]

Should the apartments be built now or next year? The conventional approach to such a decision calls for discounting the expected future cash flows by an appropriate discount rate. Suppose the probability of the apartment value going up next year is 0.8 and the probability of the apartment value falling next year is 0.2. So, the expected value of an apartment next year is Rs 0.708 million [0.8(0.75) + 0.2(0.54)]. If the apartments are properly priced, it implies that the appropriate discount rate is 18 per cent [7.08/1.18 = 6.00]. The expected value of the land if it is developed next year would be Rs 2.384 million [0.8 (2.8) + 0.2 (0.72)]. The present value of this amount at a discount rate of 18 per cent would be Rs 2.02 million [2.384/1.18]. So the apartments should be built next year.

While the decision to build the apartments next year is correct, the valuation of land is not. To value the land correctly we have to follow the option pricing approach. To illustrate the application of this approach let us express the facts of this case, using the notation described earlier:

S = present value of an apartment = Rs 0.60 million
R = interest factor = 1.12
C_u = value of the call option, just before expiration, if the stock price (apartment value, in this case) goes up = Rs 2.80 million
C_d = value of the call option, just before expiration, if the stock price (apartment value, in this case) falls = Rs 0.72 million
u = factor reflecting upward movement =

$$\frac{0.75}{0.60} = 1.25$$

d = factor reflecting downward movement =

$$\frac{0.54}{0.60} = 0.90$$

To construct the equivalent portfolio in this case, apartments will be employed the way stocks are employed to construct the equivalent portfolio for a traded call option. Using Eqs (16.10) and (16.11)

$$\Delta = \frac{C_u - C_d}{S\,(u-d)} = \frac{2.8 - 0.72}{0.60\,(1.25 - 0.90)} = 9.90$$

$$B = \frac{uC_d - dC_u}{(u-d)\,R} = \frac{1.25 \times 7.2 - 0.9 \times 2.80}{(1.25 - 0.90)\,(1.15)} = -4.02$$

The value of the call option (land) is equal to

$$\Delta \;\; S + B = 9.90 \times 0.60 - 4.02 = 1.92$$

Note that this value, obtained by using the option pricing approach, is different from the value calculated by the traditional approach (i.e. Rs 2.02 million).

VALUE OF AN OPTION TO MAKE A FOLLOW ON INVESTMENT

Your firm is looking at a proposal to manufacture an electronic educational aid called Electraid-I. The projected cash flows for this proposal are shown in Exhibit 16.8.

EXHIBIT 16.8

Cash Flows and Financial Analysis for Electraid-I

(Rs. in million)

	Year 0	1	2	3	4	5
Initial outlay	(150)					
After-tax operating cash flow		20	40	50	50	40
Terminal cash flow						30
Net cash flow	(150)	20	40	50	50	70
Present value at 18 per cent	(150)	16.9	28.7	30.5	25.8	30.6

Present value of cash inflows = 16.9 + 28.7 + 30.5 + 25.8 + 30.6 = 132.5
Investment outlay = 150
Net present value = 132.5 – 150 = – 17.5

Although the proposal has a negative *NPV*, the chief executive of your firm thinks that the project may be worthwhile. He argues: "If we undertake Electraid-I now we will be in a position to make a follow on investment in an advanced version, Electraid-II, four years down the road. If conditions are favourable, such a follow on investment can be very profitable."

Sensing the possibility of applying the option pricing model for valuing the option to make the follow on investment, you request him to provide key financial estimates for the follow on investment opportunity. He furnishes the following information:

- Electraid-II will be double the size of Electraid-I. It will require an investment of Rs 300 million (this is akin to the exercise price of a call option)
- The expected cash inflows of Electraid-II too will be twice those of Electraid I. Hence, they will have a present value of Rs 265 million as at the end of year four.

You need one more crucial piece of information: the degree of uncertainty characterising the cash inflows of Electraid-II. Your chief executive is not able to provide an estimate of this. You look at the stock price behaviour of your company and find that it has a standard deviation of 40 per cent per year. In the absence of any other information, you assume that the cash inflows of Electraid-II too would have the same standard deviation.

Armed with the above information, you can value the option to invest in Electraid-II (a call option) employing the procedure described earlier. Your calculation will be as follows:

$$\text{Asset value} = \frac{265}{(1.18)^4} = 136.7$$

$$\frac{\text{Asset value}}{\text{Present value of exercise price}} = \frac{136.7}{300/(1.12)^4} = 0.72$$

$$\text{Standard deviation} \times \sqrt{\text{Time}} = 0.40\sqrt{4} = 0.80$$

$$\frac{\text{Call value}}{\text{Asset value}} = 0.206$$

(Approximate figure from the table given in Appendix A)

$$\text{Call value} = 0.206 \times 136.7 = 28.2 \text{ million}$$

Based on this calculation you argue that a call value of Rs 28.2 million more than offsets the negative *NPV* of Rs 17.5 million and hence Electraid-I is a worthwhile proposition. Your chief executive too agrees with you because your quantitative evaluation squares with his intuitive reflection, though he is not sure how you came up with a value of Rs 28.2 million for the call option. Of course, you have a different concern about that number because you are not sure whether the assumptions underlying the calculation are realistic.

JUDGEMENTAL ASSESSMENT OF OPTIONS

Valuing the options embedded in real life projects with the help of Black-Scholes model often requires heroic assumptions. Yet the insights provided by this model can be combined with well-informed, experienced judgement to get a handle over option values. If you can identify the options and specify the circumstances under which they would be exercised, you can make an informed estimate of their values. The procedure for doing this, thus, would broadly involve three steps:

- Identify options
- Analyse environmental uncertainty
- Value options

Identify Options

Options embedded in real life projects are basically of two types: incremental options and flexibility options.

An *incremental option* provides the firm with opportunities to make profitable investments in future. Michael Porter calls an investment as a "beach-head" if it opens up new opportunities in future. For example, he refers to Procter and Gamble's acquisition of the Charmin Paper Company as a beach-head that enabled Procter and Gamble to launch a cluster of products like disposable diapers, paper towels, and bathroom tissue.

A *flexibility option* in a project gives the firm a wider latitude in manufacturing so that it can cope better with unexpected changes and exploit profitable opportunities that come its way.

Analyse Environmental Uncertainty

Options are valuable in unpredictable environments. Uncertainty creates opportunities for exercising options. Incremental options multiply when future uncertainty increases. For example, most of the foreign investments made in Europe around 1990 were motivated by future uncertainty, not current profitability. Such investments provide the "thin end of the wedge" that facilitates the exploitation of opportunities that arise in an uncertain environment. By the same token, flexibility options tend to have greater value when the environment is more uncertain.

Value the Options

Once the options provided by the project are compiled and the environmental uncertainties delineated, the value of options may be assessed. While the Black-Scholes model may not be readily applicable to options embedded in real life projects, the key ideas of this model may be combined with the experience and judgement of managers to develop a practical procedure for valuing options. Bear in mind the following insights provided by the Black-Scholes model:

- The greater the uncertainty characterising a project, the higher the value of the options embedded in the project.
- The longer the duration of a project, the higher the value of the options inherent in it.

Exhibit 16.9 presents a matrix showing the combined effect of environmental uncertainty and project duration on the relative values of cash flows and options. The percentages shown, however, are merely suggestive. They have to be, of course, specified by the project evaluator to reflect his subjective assessment.

EXHIBIT 16.9

Relative Values of Cash Flows and Options

Duration of the Project		Low	High
	Long	Cash flows : 75 Options : 25	Cash flows : 60 Options : 40
	Short	Cash flows : 95 Options : 5	Cash flows : 75 Options : 25

Environmental Uncertainty

SUMMARY

- The standard discounted cash flow analysis calls for evaluating a project on the basis of its cash flows over its economic life. Such an evaluation, however, does not capture the value of options embedded in the project. The insights provided by the option pricing theory may be applied for valuing options embedded in capital projects.
- The key terms and phrases employed in discussing options are as follows: option holder and option writer, exercise price or striking price, expiration date or maturity date, exercising the option, and European and American options.
- There are two basic types of options, call options and put options. A call option gives the option holder the right to buy a stock (or asset) at a fixed price on or before a certain date.
- The payoff of a European call option (this is a call option that can be exercised only on the expiration date) just before expiration is equal to:

  $$\text{Max}\ [\text{Stock price} - \text{Exercise price}, 0]$$

- A put option—the opposite of a call option—gives the the holder the right to sell stock (or some other asset) at specified price on or before a certain date.
- The payoff of a European put option, just before expiration, is equal to:

  $$\text{Max}\ [\text{Exercise price} - \text{Stock price}, 0\ ]$$

- Puts and calls represent basic options. They serve as building blocks for developing more complex options.
- A call option is equivalent to a combination of the underlying stock, a put option on that stock, and a debt equal to the exercise price. This equivalence is referred to as the put-call parity.
- The price of a call option must lie between the following bounds:

  $$\text{Max price}\ [\text{Stock price} - \text{Exercise price}, 0]$$

- The location of the option value (C_0) between the two bounds depends on five key factors: price of the underlying stock (S_0), exercise price (E), variance of the return on the underlying stock (σ^2), time left to expiration (t), and risk-free interest rate (r_f). The manner in which these five variables influence the value of a call option is shown in the following relationship:

  $$C_0 = f\left[\begin{array}{ccccc} S_0, & E, & \sigma^2, & t, & r_f \\ + & - & + & + & + \end{array}\right]$$

  The sign (+, –) put below a variable denotes the nature of its influence on the value of the call option.
- Black and Scholes developed the following formula (referred to commonly as the Black-Scholes model) showing how the value of a call option is related to the basic factors:

  $$C_0 = S_0 N(d_1) - \frac{E}{e^{rt}} N(d_2)$$

- Options embedded in real life projects may be valued with the help of the Black-Scholes model, if suitable quantitative estimates can be defined.
- Where quantitative estimates cannot be defined with a measure of confidence, Black-Scholes model cannot be applied meaningfully. Yet, the insights provided by this model can be combined with well-informed, experienced judgement to get a handle

over option values. The procedure for doing this would involve three steps: (i) identify options, (ii) analyse environmental uncertainty, and (iii) value options.

QUESTIONS

1. Define the following terms: option holder, option writer, exercise price, maturity date.
2. What is the payoff of a European call option and put option?
3. Define the payoffs of a call option and a put option from the point of view of the option writer (or seller).
4. What is *put-call parity* theorem? Demonstrate it.
5. Specify the boundaries within which the value of a call option falls.
6. Discuss the key factors that have a bearing on the value of a call option.
7. Show why a higher variability of the stock price has a positive effect on the value of call option.
8. Derive the value of call option using the Binomial model.
9. What is the value of a call option as per Black-Scholes model?
10. State the assumptions underlying the Black-Scholes model.
11. Describe the procedure for calculating the value of call option with the help of tables.
12. Discuss how the value of options embedded in capital projects may be judgementally assessed.

PROBLEMS

1. Alpha Company's equity is currently selling for Rs 100 per share. In a year from now it can rise to Rs 150 or fall to Rs 90. The interest rate is 15 per cent. What is the value of a call option on Alpha Company's equity as per the Binomial model?
2. Beta Company's equity is currently selling for Rs 60. In a year from now it can rise or fall. On the downside it may fall to Rs 45. The call option on Beta's equity has a value of Rs 5. If the interest rate is 16 per cent, to what level would Beta's equity rise on the upside?
3. The following information is available for Abhishek Industries:

   $$S_0 = \text{Rs } 70,\ E = \text{Rs } 72,\ r_f = 0.12,\ \sigma = 0.30$$

   Calculate the price for a six month call option as per the Black-Scholes model.
4. What is the value of a European call option (no dividends) with an exercise price of Rs 50 and an expiration date 3 months from now if the stock price is Rs 40, the variance of the stock is 0.40, and the risk-free rate is 14 per cent?
5. Your firm is looking at a proposal to manufacture a certain computer called Comp-I. The projected cash flows for this proposal are as shown below:

	Year				
	0	1	2	3	4
Initial outlay	(100)				
After-tax operating cash flow		20	50	50	20
Terminal cash flow					10

The discount rate applicable to this proposal is 20 per cent.

If your firm undertakes Comp-I proposal, it will be in a position to make a follow on investment in an advanced version, Comp-II, four years from now. Comp-II will be double the size of Comp-I in terms of investment outlay and cash inflows. The cash inflows of Comp-II would have a standard deviation of 30 per cent per year.

a. What is the net present value of the cash flows of Comp-I ?

b. What is the value of the option to invest in Comp-II ?

Assume that the risk-free rate is 12 per cent.

17

Qualitative Factors, Strategic Aspects, and Organisational Considerations

So far we discussed aspects of project appraisal and capital budgeting that are more amenable to quantitative analysis. There are, however, some important aspects of project appraisal and capital budgeting that are not easy to quantify. This chapter looks at them. It is divided into five sections:

- Qualitative factors
- Strategic aspects
- Strategic planning and financial analysis: Bridging the gulf
- Informational asymmetry and capital budgeting
- Organisational considerations

QUALITATIVE FACTORS

A mosaic of influences that can best be described qualitatively have an important bearing on capital expenditure decisions. These are discussed below:

Intuition

The use of intuition in major business decisions, including capital expenditure decisions, is far more common than people think. Many chief executives admit that ultimately their decisions are based on gut-feeling. Robert Docktor conducted an experiment in which he wired up a group of chief executive officers to an electroencephalograph. He found that the brains of chief executive officers were more active in right hemispheres, suggesting that they frequently relied on intuitive hunches to define complex problems in an open-ended state of ambiguity. Henry Mintzberg's study likewise showed that for making most of the strategic decisions managers depend on the factor of judgement rather than explicit analysis. They are often guided by their intuition and are not able to explain adequately the how or why of their strategic decisions.

Bruce D. Henderson, a leading management expert, has expressed the importance of intuition as follows:

> The final choice in all business decisions is, of course, intuitive. It must be. Otherwise, it is not a decision, just a conclusion—a printout[1].
>
> Intuition can be awesome in its value at times. It is known as good judgement in everyday affairs. Intuition is in fact the subconscious integration of all the experiences, conditioning, and knowledge of a lifetime, including the emotional and cultural biases of that life time[2].

In a similar vein, Kenichi Ohmae, a Japanese authority on management, says:

> Successful business strategies result not from rigorous analysis (which is necessary) but from a particular state of mind. In the mind of the strategist, insight and a consequent drive for achievement fuel a thought process which is basically creative and intuitive rather than rational[3].

Vision

Most successful business groups/companies all over the world are guided by a vision of its leaders, which serves as a superordinate goal and influences the investment decisions directly and indirectly. Here are some examples of business visions:

IBM : Value-added leadership position
Honda : No. 1 producer of the best motorcycles in the world
Ambani group : An integrated empire
Bajaj Auto : Global player
TELCO : Technological competence
ITC : India International
Bell System : Our business is service
AV Birla Group : Diversified empire in the core sector

Superstition

Many businessmen consult astrologers or depend on some other superstitious counsel. Wit the following statements:

> What do businessmen have to lose if, plain business sense apart, they also want to know if the planets are favourably disposed toward them.
>
> The more money a businessman makes, the more insecure he feels. Consulting an astrologer is a therapeutic experience. If you are going through a bad phase and are told that it has been caused due to the adverse effects of planets in your horoscope, you do not completely blame yourself. Moreover, most Indian businessmen are by nature religious.
>
> There is no businessman in India who doesn't consult an astrologer, although most of them lack the conviction and courage to admit it.

The dependence on astrological advice or superstitious counsel is not confined to India. It is pervasive globally. In a profoundly insightful book, Kenneth Boulding writes:

> The persistence of superstition even into a supposedly scientific age is testimony to the power of traditional images in ambiguous situations. It is a curious fact, for instance, that even in the most advanced societies the daily paper frequently carries a column of astrological advice!![4]

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1 and 2 Bruce D. Henderson, *Henderson on Corporate Strategy*, New York, The New American Library, 1979.

3 Kenichi Ohmae, *"The Mind of the Strategist,"* McGraw-Hill Book Company, 1982.

4 Kenneth Boulding, *The Meaning of the 20th Century*, New York, Harper & Row, 1964, p. 44.

Astrologers and psychologists have argued that magical rites and superstitious behaviour make the world look more deterministic and instil confidence in our ability to manage it. Superstitious beliefs seem to help in:

- Relieving anxiety
- Imparting a sense of control
- Encouraging necessary activity

Hence, such beliefs persist. And the more unpredictable or uncertain the future appears to be, the greater may be the psychological urge to rely on superstitions.

Politics

Internal political elements often have an important bearing on capital budgeting decisions. Various levels of management tend to get divided into factions. Mutual loyalties among people belonging to the same faction may lead to acceptance of otherwise marginal or even sub-marginal projects. On the other hand, negative feelings among people belonging to different factions may lead to rejection of otherwise promising projects. Put differently, internal political games can mar the quality of decision making and investment proposals may not be viewed in an unbiased and objective manner.

Sponsorship

A project cannot be divorced from its sponsor. Research on decision-making processes of top management suggests that a decision at this level is likely to be a bet on the sponsor of the project. The facts, the projections, and even the project tend to be secondary in importance if the questions asked by the top management are: Who is the sponsor of the project? What is his commitment to the project? What is his track record? Will he be able to surmount obstacles on the way and deliver the goods?

Intangible Benefits

A capital project may generate some benefits that cannot be easily quantified. It may increase the flexibility available to the organisation; it may improve the attractiveness of the product; it may give the organisation a sense of pride; it may make the work environment more pleasing; it may strengthen the technological capability of the firm; it may enhance the morale of the firm. Referred to generally as intangibles, these benefits cannot be translated into monetary terms. Yet, they are relevant and cannot be ignored in investment decision making.

STRATEGIC ASPECTS

Capital budgeting is the principal instrument for implementing corporate strategy. Yet the tie-in between corporate strategy and capital budgeting is often loose and tenuous. Wit the following:

- Investment proposals are often considered as self-contained projects and viewed more or less in isolation. The rationale preferred for this approach is that if individual proposals are sound, a collection of such proposals should represent a meaningful commitment of funds.

- The sponsors of proposals, particularly operating personnel, tend to, quite understandably, view the proposals from their limited perspective. An operating person, for example, may justify an investment in terms of increase in output and decrease in unit cost. The effect of the investment on the break-even point or inventory level may be beyond his concern.
- Many investment proposals, suggested by people down the line and apparently fulfilling certain standards of profitability, may be rejected by the capital budgeting committee because they conflict with the rationale of corporate strategy. This may breed frustration and cynicism about the role of formal analysis.

Strengthening the Links Between Corporate Strategy and Capital Budgeting

In order to ensure that corporate strategy and long-range plans firmly undergird the capital budgeting process, the following ought to be done:

- Long-range planning should precede capital budgeting.
- Long-range plans should be formalised and communicated to all persons involved in the process of capital budgeting.
- During the capital budgeting exercise, investment proposals should be viewed in the context of the critical premises of long-range plans.

A suggested time table linking business planning and capital budgeting is given in Exhibit 17.1.

EXHIBIT 17.1

Linkages Between Business Planning and Capital Budgeting

	Business planning	Capital budgeting	
April-August	Several scenarios are explored		
September	Initial premises are agreed to	Initial capital budgeting guidelines are formulated	
October-December	Work is continued toward developing a final formal business plan	October-January	Capital budget selection is carried out in divisions and departments
January	Final business plan is adopted	February	Capital budget is approved by the executive committee
		March	Capital budget is approved by the board

Missions and Funds Allocation

In the context of our present discussion which is concerned with the linkage between corporate strategy and capital budgeting, it is somewhat relevant to mention the use of strategic missions as the basis of funds allocation at the Department of Defence, U.S.A. Traditionally, the approach used for budgetary allocation at the Department of Defence, U.S.A., was to allocate the budgetary pie to the three services, Army, Navy and Air Force. When Robert McNamara took office as Secretary, Department of Defence, he introduced a new approach to budgetary allocation which was based on nine program elements reflecting the major missions of the Department of Defence. Program Element No. 1, for example, represented development of "Strategic Retaliatory Force" and the budget for this program covered bombers, polaris submarines, and land based inter-continental ballistic missiles.

The approach adopted by the Department of Defence, U.S.A. can be meaningfully applied to a corporate entity. Determining corporate missions admittedly is a significant managerial challenge. Once the missions are delineated and communicated they serve as the base for resource allocation. If missions are not properly developed and communicated, funds allocation becomes, as Tilles puts it, "an exercise in gamesmanship rather than a rational matching of means and ends".

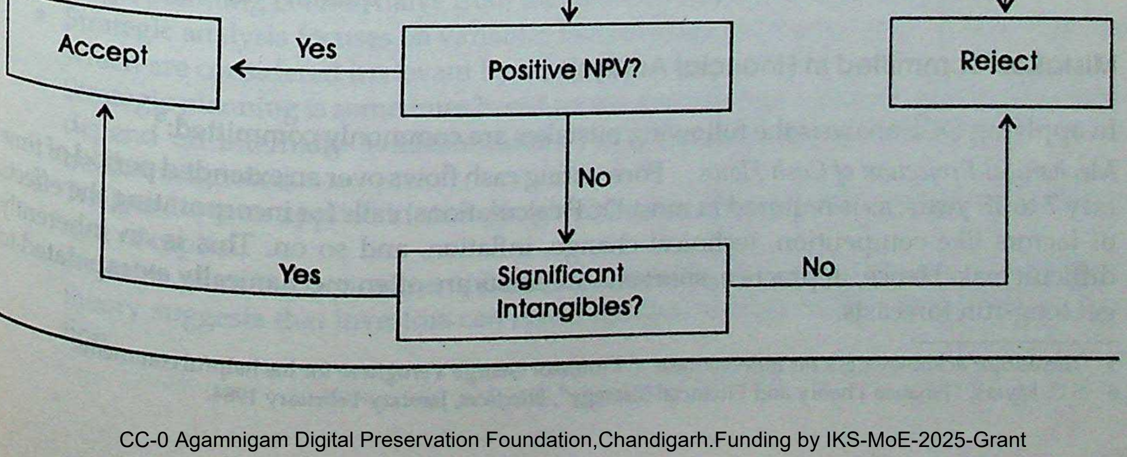
An Approach to Decision Making

To determine whether a project is worthwhile or not, strategic factors, financial payoffs, and intangible benefits may be combined in the manner shown in Exhibit 17.2. The key guidelines underlying the approach displayed in this exhibit are:

- In a decision involving measurement as well as judgement, as far as possible, separate the quantifiable and intangible factors.
- Don't rely exclusively on measurable factors and spurious over-quantification. Put differently, avoid the 'what counts counts' bias.

EXHIBIT 17.2

An Approach to Decision Making



STRATEGIC PLANNING AND FINANCIAL ANALYSIS : BRIDGING THE GULF[5]

Strategic planning, among other things, is concerned with the issue of allocating a firm's resources across different lines of business. In this sense, strategic planning may be viewed as capital budgeting on a grand scale. Yet we find that strategic planning is often naive from the financial point of view and/or the results of strategic planning and financial analysis are not properly reconciled.

This section explores why a gulf exists between strategic planning and financial analysis and shows how the differences between the two may be reconciled. It is organised as follows:

- Different frameworks
- Mistakes committed in DCF analysis
- Inadequacy of DCF analysis
- Financial naivete' of strategic planning
- Reconciling the differences

Different Frameworks

The frameworks employed in strategic planning and financial analysis differ. The salient differences are highlighted below:

	Strategic planning	Financial analysis
Objective	Achieve a balanced goal structure	Maximise shareholder value
Responsibility		
– Internal	Corporate planning department	Finance department
– External	Consultant	Investment banker
Type of analysis	Primarily qualitative	Primarily quantitative
Techniques of analysis	SWOT analysis	Discounted cash flow model
	Portfolio planning models	Option pricing model
Advantage	Comprehensive qualitative assessment	Disciplined quantitative reasoning
Disadvantage	Lacking in rigor	Omission of hard-to-quantify factors

Mistakes Committed in Financial Analysis

In applying DCF analysis the following mistakes are commonly committed:[6]

Mechanical Projection of Cash Flows Forecasting cash flows over an extended period of time (say 7 to 15 years, as is required in most DCF calculations) calls for incorporating the effects of factors like competition, technical change, inflation, and so on. This is an inherently difficult task. Hence, in practice, short-run forecasts are often mechanically extrapolated to get long-run forecasts.

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[5] The author acknowledges his indebtedness to Professor George Verughese for his helpful comments.

[6] S.C. Myers, "Finance Theory and Financial Strategy", *Interfaces*, January-February 1984.

Optimistic Bias in Cash Flows Knowledgeable observers of capital budgeting believe that profitability is overstated because the initial investment is understated and operating cash flows exaggerated. The principal reasons for such optimistic bias appear to be (i) intentional overstatement, (ii) lack of experience, (iii) myopic euphoria, and (iv) capital rationing.

Emphasis on IRR IRR is the most commonly used DCF criterion in practice. It is preferred because it is a relative measure and it seems more appropriate when the investment funds are limited. IRR, however, is biased against long-lived, capital-intensive projects which may be of greater strategic significance to the firm. Ideally, NPV, conceptually superior to all other criteria, should be used as it has no bias against such projects.

Inconsistent Treatment of Inflation Often inflation is treated inconsistently in DCF analysis. While discount rates are defined in nominal terms to reflect the factor of inflation, cash flows are expressed in real terms or only partially adjusted for inflation. Such an inconsistency clearly discriminates against long-lived projects which may have substantially positive NPVs.

Unreasonably High Discount Rates Discount rates used in DCF calculations are sometimes set unrealistically high. This may be because of one or more of the following reasons: (i) Management may lack familiarity with what the normal returns in the capital market are (ii) Premiums are asked for risk that can be easily diversified away. (iii) Required returns are raised to compensate for the optimism of project sponsors. Such an adjustment makes sense only if the sponsor bias increases geometrically over time. This, however, is rarely true.

Inadequacy of DCF Analysis

Even if the mistakes alluded to in the preceding discussion are avoided, DCF analysis is deficient for evaluating projects which have options embedded in them. Consider a project which is in the nature of a 'beach-head'. If the firm succeeds in this project, it can make a follow on investment. In other words, there is a second-stage investment opportunity—indeed, there may be opportunities beyond the second-stage as well. The DCF method is not enough for evaluating a project like this because it does not take into account the value of the option(s) embedded in the project. DCF analysis must be combined with option valuation. Fortunately, option pricing models promise help in valuing options inherent in real life project.

Financial Naiveté of Strategic Planning

Strategic planning is often naive from the financial point. Wit the following:

- Strategic analysis focuses on variables like earnings per share and book rate of return which are considered irrelevant by modern finance theory.
- Strategic planning is sometimes based on the premise that a firm should, by and large, depend on internally available funds. Put differently, the existence of the capital market is ignored.
- The hurdle rates applied in strategic planning are often not related to the opportunity cost of capital.
- Strategic planning typically emphasises a diversified business portfolio when finance theory suggests that investors can resort to more efficient "home made" diversification.

Reconciling the Differences

To bridge the gap between strategic planning and financial analysis, a conscious effort is required on both the sides.

- Financial analysts must avoid the mistakes commonly committed by them and expand the scope of their work to reflect the values of options embedded in investments of strategic significance.
- Strategic planners must understand the logic of DCF analysis, acquire familiarity with the meaning of capital market data, and calculate the NPVs, at least as a rough check on the results of their analysis.

While a complete reconciliation is not practical, a sincere attempt to see each other's point of view and to unearth hidden premises will facilitate better communication and understanding. This will ensure that strategic analysis is not financially naive and financial analysis is not insensitive to strategic issues.

INFORMATIONAL ASYMMETRY AND CAPITAL BUDGETING

The conventional 'text book' approach to capital budgeting is starkly simple: accept projects which have a positive NPV. It does not make any difference whether the investment decision making is centralised or decentralised; it is irrelevant whether the existing firm implements it or a newly set up firm executes it; it does not matter what mix of financing is employed.

The behaviour of firms, however, is not always in conformity with what has been said above. In the real world:

- Firms often ration capital and do not invest in all projects that have positive NPVs.
- A lot of attention is paid to the extent to which capital budgeting decisions are centralised.
- Often, new projects are organised as separate corporate entities.
- The mix of financing is considered to be very important.

Why does a discrepancy exist between what the conventional model says and how the real world firms behave? Informational asymmetries of various sorts seem to create such a hiatus. Informational asymmetry exists if the transacting parties have unequal information, ex ante or ex post.

We may classify informational asymmetry into three broad types:

- Informational asymmetry between shareholders and bondholders
- Informational asymmetry between current shareholders and prospective shareholders
- Informational asymmetry between managers and shareholders

A brief discussion of the distorting effects of different types of informational asymmetries follows.[7]

Informational Asymmetry Between Shareholders and Bondholders

Informational asymmetry between shareholders and bondholders has two possible distorting consequences.

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[7] Anjan V.Thakor, "Corporate Investments and Finance," *Financial Management*, Summer 1993.

Asset substitution moral hazard : Shareholders may prod management to substitute riskier assets for safer assets, at the expense of bondholders

Underinvestment moral hazard : In firms with risky debt, shareholders have an incentive to avoid investing in new projects that have a positive NPV, because they would not like the cash flows of new projects to be diverted for servicing existing risky debt.

Informational Asymmetry Between Current Shareholders and Prospective Shareholders

When there is informational asymmetry between current shareholders and prospective shareholders, the latter will not fully appreciate the future payoffs of various resource commitments. As the firm's stock price may not fully reflect the benefits of such resource commitments, the new shareholders will not fully share the cost of resource commitments even though they partake in the benefits arising from them. If the firm is interested in maximising the wealth of present shareholders, it may choose projects that are likely to be different from those that would be chosen in a symmetric information setting. The common distortions resulting from such informational asymmetry are:

- Preference for projects with shorter payback period.
- A greater degree of capital rationing.
- Centralisation of capital budgeting.
- Accumulation of liquidity despite the existence of positive NPV projects.

Informational Asymmetry Between Managers and Shareholders

Managers are interested in maintaining and building their reputation. Since, as compared to shareholders, they are typically better informed about the payoffs of projects they can trade on the relative ignorance of the latter. This gives them latitude to choose investments aimed at building their reputation rather than enhancing the wealth of shareholders. As David Hirshleifer[8] has suggested, the concern for managerial reputation may lead to three kinds of distortions in investment decisions.

Visibility Bias Managers seek to improve short term indicators of performance.

Resolution Preference Managers attempt to advance the arrival of good news and delay the announcement of bad news.

Mimicry and Avoidance Managers try to imitate the actions of superior managers and avoid the actions of inferior managers.

These incentives may lead to the following investment biases:

- Squeezing of an investment to improve short term cash flows.
- Premature liquidation of assets to show that they are worth a lot.
- Adoption of projects with earlier payoffs.
- Avoidance of worthwhile projects that carry risk of early failure to protect short-term reputation.

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[8] David Hirshleifer, "Managerial Reputation and Corporate Investment Decisions," *Financial Management*, Summer 1993, pp. 145-159.

- Escalation of inferior projects to avoid admission of failure.
- Undertaking projects which are supposed to have benefits in distant future to protect short-term reputation.
- Conformity with other managers to avoid the 'odd manager' label.
- Deviation from other managers to avoid seeming mediocre.

ORGANISATIONAL CONSIDERATIONS

In order to be meaningful and viable, the capital budget of a firm must satisfy some conditions:

- It must be compatible with the resources of the firm.
- It must be controllable.
- It must be endorsed by the executive management.

Compatibility with Resources

The capital budget of a firm must be compatible with its resources—financial capacity and managerial capability.

Financial Capacity The financial capacity of a firm may be estimated as follows: operating cash flow—fixed funding requirements + potential funding sources.

Operating Cash Flow The operating cash flow of a firm is defined as: profit after tax + depreciation + other non-cash charges – increase in working capital (or + decrease in working capital)

Fixed Funding Requirement This is equal to: debt repayment obligation + preference capital repayment obligation + preference dividend + normal equity dividend.

Potential Funding Sources These consist of: excess cash balance + saleable fixed assets + reserve borrowing capacity + new equity issue.

Managerial Capability The managerial capability of every organisation has its own limitation. Management competence in one industry does not necessarily imply competence in another industry. This sets a limit—which of course can be overcome over a period of time —on investment in unrelated lines of activity. Further, imbalances in organisational skills may be an inhibiting factor. A firm may have outstanding engineering and production expertise that may not be matched by marketing skills, which may be, at least in the short-run, a factor limiting growth.

Assessing the managerial capability is more difficult than estimating financing capacity. The methods of evaluation in this area being weak, there may be a tendency to gloss over it or side-step it. However, the inability to identify critical managerial limitations and organisational imbalances can seriously vitiate funds allocation. Indeed, this is one of the most vulnerable facets of capital budgeting.

Controllability

As the business environment is continually changing and evolving, even the best conceived business plans may turn out to be ill-advised and poorly timed. Hence, sound controls should be instituted in the process of capital budgeting. This involves the following:

- The base level spending and expansion investments should be segregated.

- Sound profitability criteria should be applied to expansion investments.
- Projects included in the capital budget should be thoroughly reviewed prior to actual implementation.
- Major projects should be divided into sub-phases for purposes of controlling expenditures.
- Actual costs must be periodically compared against planned costs.

Base Level Spending and Expansion Investments The segregation of base level spending and expansion investments, a major aspect of control, deserves some elaboration. Base level spending, representing outlays on 'required' investments (also referred to sometimes as 'maintenance' investments), should be carefully distinguished from expansion investments also referred to as 'discretionary' investments or 'growth' investments. Base level spending represents the minimum spending required for sustaining current operations. If the base level capital budget is not properly drawn up, current operations may be 'short-changed' or 'gold-plated'.

As against the base level spending, expansion projects are discretionary in nature. Selection of expansion projects is a test of managerial initiative, insight, imagination, and judgement. In view of mistakes that can be made with respect to expansion investments, the capital budgeting process should give high visibility and prominence to such projects.

Executive Management Endorsement

The capital budget of the firm should be fully backed by the executive management. Without the endorsement of executive management, the capital budgeting process may lack meaning and usefulness. Endorsement of executive management is required at all stages: long-range planning, funds planning, planning to strengthen managerial capabilities and rectify organisational imbalances, and development of budgetary controls.

Endorsement of executive management means (i) conviction in the long-range strategy of the firm, (ii) strong desire to implement the approved capital budget, and (iii) willingness to be subjected to the discipline of capital budgeting. Conviction in the long-range strategy and the concomitant tactical plans may be developed by discussion leading to some general agreement. A difficult task, this is critical for generating enthusiasm and support for the capital budget. The desire to implement the approved capital budget is reflected by the initiatives taken by the management to expedite proposals, to arrest adverse developments, and to bring about organisational changes. The willingness to be subjected to the discipline of capital budgeting is manifested in the schedules drawn, approval procedures established, and corrective mechanisms developed.

SUMMARY

- A mosaic of influences that can best be described qualitatively have an important bearing on capital expenditure decisions. Mainly, these are: intuition, vision, superstition, politics, sponsorship, and intangible benefits.
- Capital budgeting is the principal instrument for implementing corporate strategy. Hence the two should be properly linked. In particular: (i) Long-range planning should precede capital budgeting. (ii) Long-range plans should be formalised and communicated to all persons involved in the process of capital budgeting. (iii) During the capital

budgeting exercise, investment proposals should be viewed in the context of the critical premises of long-range plans.

- In a decision involving measurement as well as judgement, as far as possible, separate the quantifiable and intangible factors.
- Strategic planning, among other things, is concerned with the issue of allocating a firm's resources across different lines of business. In this sense, strategic planning may be viewed as capital budgeting on a grand scale.
- Strategic planning is often naive from the financial point of view and/or the results of strategic planning and financial analysis are not properly reconciled.
- The frameworks employed in strategic planning and financial analysis differ on several dimensions like objective, responsibility, type of analysis, and techniques of analysis.
- In applying DCF analysis, the following mistakes are commonly committed: mechanical projection of cash flows, optimistic bias in cash flows, emphasis on IRR, inconsistent treatment of inflation, and unreasonably high discount rates.
- To bridge the gap between strategic planning and financial analysis, a conscious effort is required on both the sides. Financial analysts must avoid the mistakes commonly committed by them and strategic planners must understand the logic of DCF analysis.
- The behaviour of firms in the real world is often at variance with the text book model. The discrepancy arises mainly because of informational asymmetries.
- Informational asymmetry exists if the transacting parties have unequal information, ex ante or ex post. There are three kinds of informational asymmetry: (i) information asymmetry between shareholders and bondholders, (ii) informational asymmetry between current shareholders and prospective shareholders, and (iii) information asymmetry between managers and shareholders.
- In order to be meaningful and viable, the capital budget of a firm must satisfy some conditions: (i) It must be compatible with the resources of the firm. (ii) It must be controllable. (iii) It must be endorsed by the executive management.

QUESTIONS

1. Discuss the influence of qualitative factors in capital budgeting.
2. "The tie-in between corporate strategy and capital budgeting is often loose and tenuous." Comment.
3. Suggest ways and means of strengthening the linkage between long-range planning and capital budgeting.
4. What are the salient differences in the frameworks applied in strategic planning and capital budgeting?
5. Discuss the mistakes commonly committed in applying the DCF analysis.
6. What are the different kinds of informational asymmetries? What types of distortions do they introduce in project choices?
7. What conditions should the capital budget satisfy in order to be meaningful and viable?
8. How would you measure the financial capacity of the firm?
9. What should be done to ensure that sound controls are instituted in the process of capital budgeting?
10. "The capital budget of the firm should be fully backed by executive management." Discuss.

PART 5

IMPLEMENTATION

Project Management

Network Techniques for Project Management

18

Project Management

The basic building blocks of the traditional form of organisation are a functional division of management and a well-defined hierarchical structure. Typically, a firm is organised into various departments, such as production, purchasing, marketing, finance, personnel, engineering, and research and development. Some of these departments have a line function and the others a staff function. Line managers have the principal responsibility for achieving the goals of the firm and are vested with decision-making authority. Staff managers primarily serve in an advisory capacity—of course, within the staff departments they enjoy administrative powers.

The traditional form of organisation is quite appropriate for handling established operations which are characterised by a continuous flow of repetitive work, with each department attending to its specific functions—in such a setting, relatively stable inter-departmental and inter-personal relationships emerge. However, the traditional form of organisation is not suitable for project management. Why? There are several reasons: (i) a project is a non-routine, non-repetitive undertaking often plagued with many uncertainties; (ii) the relationships in a project setting are dynamic, temporary, and flexible; and (iii) a project requires coordination of the efforts of persons drawn from different functional areas and contributions of external agencies. Due to these reasons, project management calls for a different form of organisation, sharper tools of planning and control, and improved means of coping with human problems.

This chapter, concerned with various issues relating to project management, is divided into five sections:

- Forms of project organisation
- Project planning
- Project control
- Human aspects of project management
- Pre-requisites for successful project implementation

FORMS OF PROJECT ORGANISATION

The traditional form of organisation is not suitable for project work for the following reasons: (i) it has no means of integrating different departments at levels below the top management, and (ii) it does not facilitate effective communication, coordination, and control when several functional departments, with different professional backgrounds and orientations are involved in project work under time and cost pressures, which often call for overlap, at least partial, of development, design, procurement, construction, and commissioning work.

Hence there is a need for entrusting an individual (or group) with the responsibility for integrating the activities and functions of various departments and external organisations involved in the project work. Such an individual may be called the project manager or project coordinator. Depending on the authority that is given to the person responsible for the project, the project organisation may take one of the following three forms:

- Line and staff organisation
- Divisional organisation
- Matrix organisation

Line and Staff Organisation

In this form of project organisation, a person is appointed with the primary responsibility of coordinating the work of the people in the functional departments. Such a person, referred to commonly as the project coordinator, acts essentially in a staff position to facilitate the coordination of line management in functional departments. The project coordinator does not have authority and direct responsibility of line management. He serves as a focal point for receiving project-related information and seeks to promote the cause of the project by rendering advice, sharing information, and providing assistance. He may gently coax line executives to strive for the fulfilment of project goals. Deprived of formal organisational authority, he may find it difficult to exert leadership and feel unsure of his role. His influence would depend on his professional competence, closeness to top management, and persuasive abilities. Clearly, this is a weak form of organisation which may be employed mostly for small projects—it is certainly not suitable for large projects.

Divisional Organisation

Under this form of project organisation, a separate division is set up to implement the project. Headed by the project manager, this division has its complement of personnel over whom the project manager has full line authority. In effect, this form of organisation implies the creation of a separate goal-oriented division of the company, with its own functional departments. While the project manager still has the problem of coordinating the inputs of other organisations involved in the project, he has total formal control over the division heads.

A very strong form of project organisation, the divisional project organisation facilitates the process of planning and control, brings about better integration of efforts, and strengthens the commitment of project-related personnel to the objectives of the project. It considerably improves the prospect of fulfilling the time and budget targets.

This form of organisation, however, may entail an inefficient use of the resources of the firm. It may result in an unnecessary duplication of specialists in the company, because of the necessity to allocate them in total to each project. Further, it may be difficult to achieve a higher degree of specialisation of expertise because the divisional project organisation may have to manage with, say, one mechanical engineer, rather than two specialists.

Matrix Organisation

The line and functional form of organisation is conducive to an efficient use of resources but is not suitable for an effective realisation of project objectives. The divisional form of organisation, on the other hand, is suitable for an effective realisation of project objectives but is not conducive to an efficient use of resources. The matrix form of organisation, the third form of project organisation, seeks to achieve the twin objectives of efficient use of resources and effective realisation of project objectives—at the cost of greater organisational complexity, of course.

In a matrix organisation, the personnel working on the project have a responsibility to their functional superior as well to the project manager. This means that the authority is shared between the project manager and the functional managers. The authority and influence of the project manager cut across the traditional vertical line of command. Exhibit 18.1 shows the organisation chart for a typical matrix organisation. As is evident from this exhibit, the project manager integrates the contributions of personnel in various functional departments toward the realisation of project objectives. While the personnel maintain their departmental affiliation and are responsible to their functional superiors, they are responsible to the project manager as well.

The matrix form of organisation is incongruent with the traditional organisation theory: there is dual subordination; responsibility and authority are not commensurate; the hierarchical principle is ignored. This clearly implies that the matrix form of organisation involves greater organisational complexity and creates an inherently conflictive situation. Yet it seems to be a better vehicle for the simultaneous pursuit of the twin objectives—efficient utilisation of resources and effective attainment of project objectives—which were discussed earlier.

PROJECT PLANNING

Projects involving few activities, resources, constraints, and inter-relationships can be visualised easily by the human mind and planned informally. However, when a project crosses a certain threshold level of size and complexity, informal planning has to be substituted by formal planning. The need for formal planning is indeed much greater for project work than for normal operations. Without effective planning, there may be chaos.

Functions of Planning

Planning, a vital aspect of management, serves several important functions:

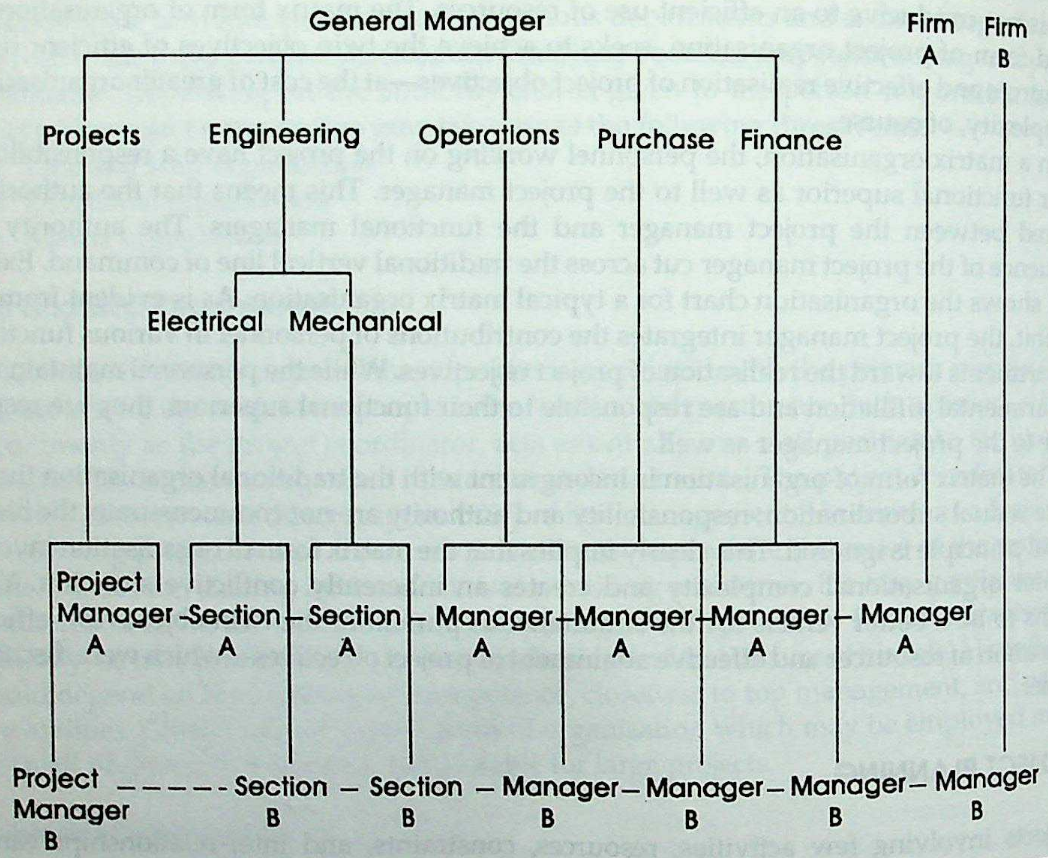
- It provides a basis for organising the work on the project and allocating responsibilities to individuals.
- It is a means of communication and coordination between all those involved in the project.
- It induces people to look ahead.
- It instills a sense of urgency and time consciousness.
- It establishes the basis for monitoring and control.

Areas of Planning

Comprehensive project planning covers the following:

EXHIBIT 18.1

Matrix Organisation


General Manager
Firm A
Firm B
Projects
Engineering
Operations
Purchase
Finance
Electrical
Mechanical
Project Manager A
Section A
Section A
Manager A
Manager A
Manager A
Manager A
Project Manager B
Section B
Section B
Manager B
Manager B
Manager B
Manager B

- *Planning the project work* The activities relating to the project must be spelt out in detail. They should be properly scheduled and sequenced.
- *Planning the manpower and organisation* The manpower required for the project (managers, technologists, operators, and others) must be estimated and the responsibility for carrying out the project work must be allocated.
- *Planning the money* The expenditure of money in a time-phased manner must be budgeted.
- *Planning the information system* The information required for monitoring the project must be defined.

Project Objectives and Policies

Often, the focus of project planning is on questions like who does what and when. Before such operational planning is done, the objectives and policies guiding the project planning exercise must be articulated. The questions to be answered in this context are: What are the technical and performance objectives? What are the time and cost goals? To what extent should the work be given to outside contractors? How many contractors should be employed? What should be the terms of contract?

Well-defined objectives and policies serve as the framework for the decisions to be made by the project manager. Throughout the life of the project, he has to seek a compromise between the conflicting goals of technical performance, cost standard, and time target. A clear articulation of the priorities of management will enable the project manager to take expeditious actions.

Work Breakdown Structure

The work breakdown structure, as its name suggests, represents a systematic and logical breakdown of the project into its component parts. It is constructed by dividing the project into its major parts, with each of these being further divided into sub-parts. This is continued till a breakdown is done in terms of manageable units of work for which responsibility can be defined. Thus the work breakdown structure helps in:

- Effective planning by dividing the work into manageable elements which can be planned, budgeted, and controlled.
- Assignment of responsibility for work elements to project personnel and outside agencies.
- Development of control and information system.

Work Breakdown Structure and Project Organisation The project organisation represents formally how the project personnel and outside agencies are going to work. The work breakdown structure defines what work is to be done in a detailed manner. To assign responsibility for the tasks to be done, the work breakdown structure has to be integrated with the project organisation structure. This calls for blending the vertical breakdown of the work (as arrived in the work breakdown structure) with the project organisation structure. This results in delineation of project tasks which are the specific responsibilities of organisational units/managers. The technical name given to such a project task is *cost account.* A cost account represents a unit of work (i) which is defined in fairly concrete terms, (ii) for which a single person is responsible, and (iii) for which a budget of expenditure and manpower requirement can be prepared meaningfully.

Life Cycle of a Project

The important stages in the life cycle of a project are:

- Project development and preliminary engineering
- Bidding and contract negotiation
- Engineering design
- Purchase and procurement
- Construction
- Commissioning

In planning these stages, one has to bear in mind two concepts: the rolling wave concept and the integration concept. According to the rolling wave concept, when detailed planning is done for project development and preliminary engineering, summary planning would be done for the remaining steps. When the actual work on project development and preliminary engineering commences, detailed planning would be done for the next stage which is concerned with bidding and contract negotiation, and so on. According to the integration concept, planning for all the stages must be integrated, even though detailed planning would be done in accordance with the rolling wave concept. The need for integrative planning stems from the inter-relationship among various stages of project work. This need is further reinforced when the compulsion to reduce the project duration leads to overlap, at least partial, of various stages of the project.

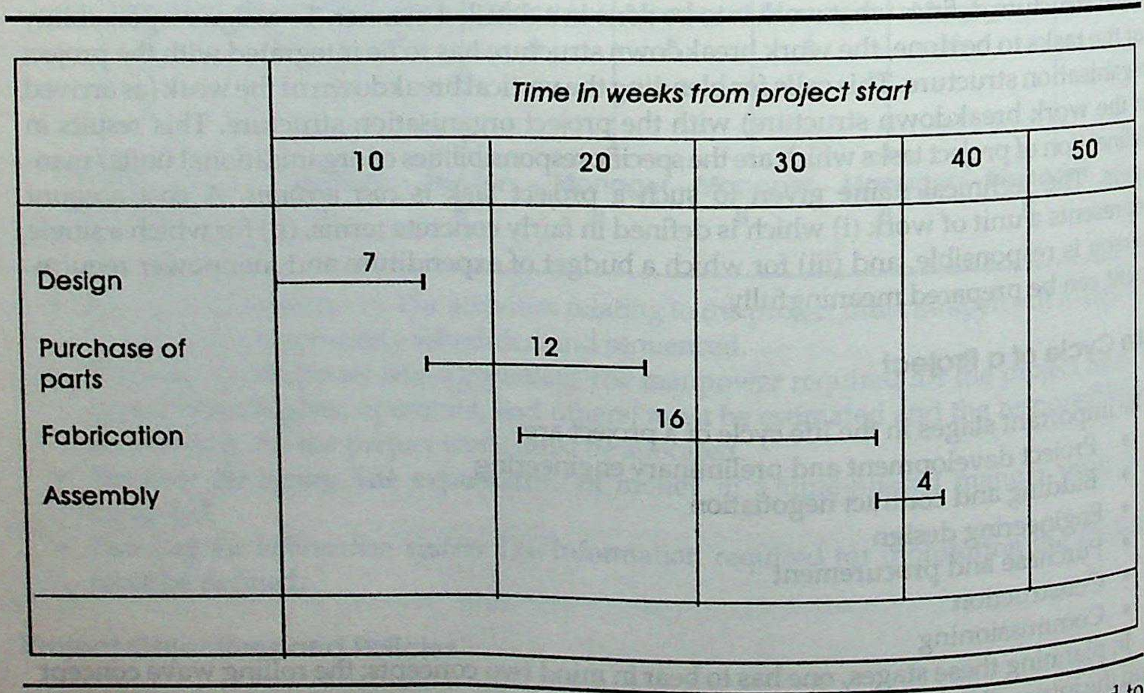
Tools of Planning

The oldest formal planning tool is the bar chart, also referred to as the Gantt chart or the multiple activity chart. In the last four decades, network techniques have received considerable attention. This section briefly describes the nature of these tools of planning. (Network techniques, which warrant a detailed discussion, are covered at length in the following chapter.)

Bar Chart This is a pictorial device in which the activities are represented by horizontal bars on the time axis. The left hand end of the bar shows the beginning time, the right hand end the ending time. The duration of the activity is indicated by the length of the bar. The manpower required for the activity is shown by a number on the bar. An illustrative bar chart is shown in Exhibit 18.2.

EXHIBIT 18.2

An Illustrative Bar Chart

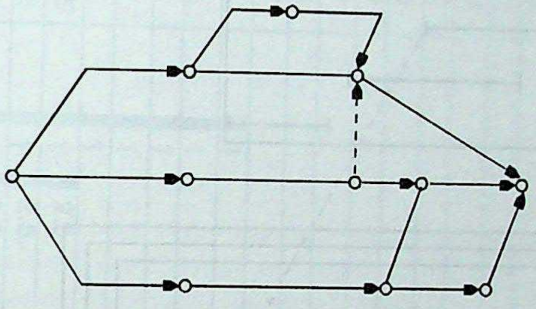


The advantages of the bar chart are: (i) it is simple to understand; (ii) it can be used to show progress; and (iii) it can be used for manpower planning. The bar chart, however, suffers from some disadvantages which limit its usefulness: (i) it cannot show interrelationship among activities on large, complex projects; (ii) there may be a physical limit to the size of the bar chart, which may limit the size of the project that can be planned with this technique; and (iii) it cannot easily cope with frequent changes or updating.

Network Techniques These are more sophisticated than the traditional bar chart. In these techniques, the activities, events, and their inter-relationships are represented by a network diagram, also called an arrow diagram. Exhibit 18.3 shows an illustrative network diagram.

EXHIBIT 18.3

An Illustrative Network Diagram



The advantages of network techniques are: (i) they can effectively handle inter-relationships among project activities; (ii) they identify the activities which are critical to the completion of the project on time and indicate the float (or spare time) for other activities; (iii) they can handle very large and complex projects; and (iv) they can be easily computerised and updated.

While the network techniques are a superior tool for project planning, they suffer from several drawbacks: (i) being more complicated than the traditional bar chart they are not easily understood by the project personnel; and (ii) they do not define an operational schedule which tells who does what and when.

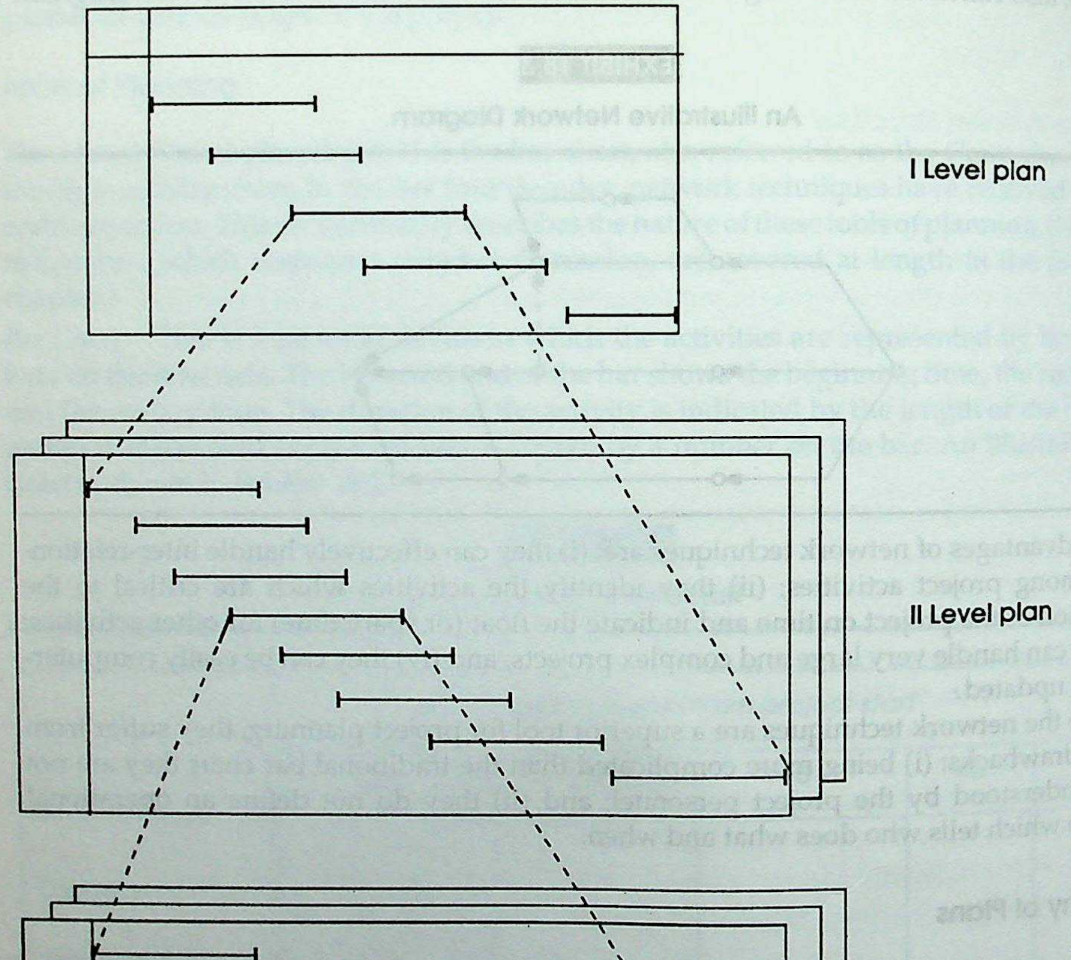
Hierarchy of Plans

A large project may consist of thousands (or even tens of thousands) of activities. A project plan consisting of such a large number of activities cannot be comprehended and visualised by the human mind. Hence, the global plan of so many activities may be held in a computer memory and structured on a hierarchical and modular basis in terms of plans of much smaller size, consisting of, say, 30 to 150 activities. Thus, for a large project a hierarchy of plans, having varying levels of detail, as illustrated by Exhibits 18.4 and 18.5 need to be prepared.

I Level Plan A highly summarised plan, the I level plan shows the broad activities of the project, such as engineering design, contract negotiation, procurement, construction, and commissioning with very elementary breakdown. It may serve as the basis for making rough estimates for overall resources and outlays. It would indicate the major inter-relationships in the project and suggest what could be the critical phases of the project. Such a plan is useful for strategic planning and establishing project objectives and policies. It serves as a tool for top management review.

EXHIBIT 18.4

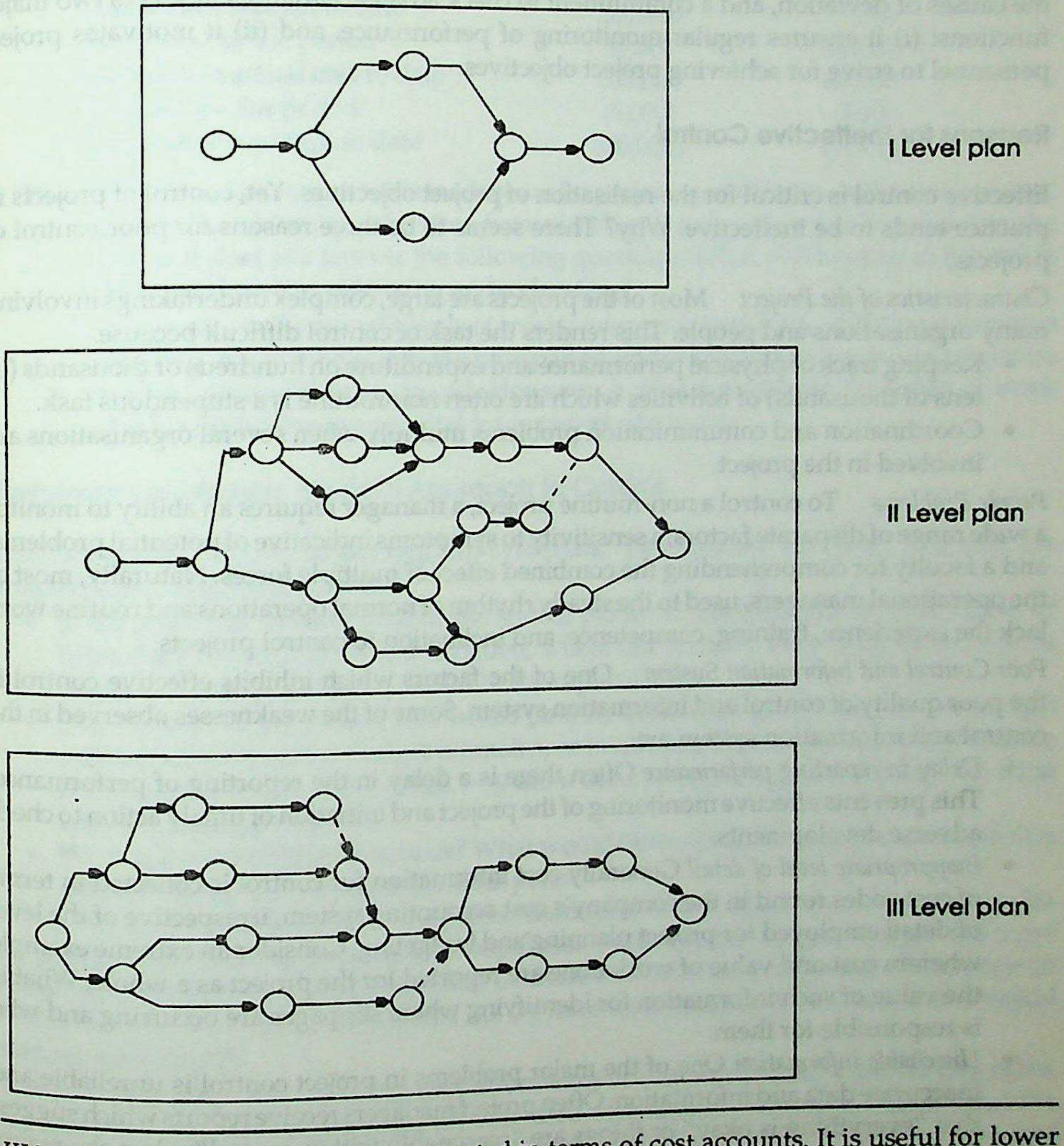
A Hierarchy of Bar Charts



II Level Plan The activities in the summary plan (at the I level) are shown in greater detail in the II level plan. This permits a more detailed examination of various stages of the project, so that inter-relationships can be properly established. The II level plan is essentially a tool of middle management planning, decision making, and control. It facilitates (i) identification of individuals responsible for various work packages,[1] (ii) aggregative manpower planning, and (iii) broad scheduling of project work.

EXHIBIT 18.5

A Hierarchy of Network Plans



III Level Plan This is the plan constructed in terms of cost accounts. It is useful for lower levels of management. It helps them in week to week, or even day to day, planning and control. Such a plan is based on a very detailed estimate of resource requirement, funds availability, project interrelationships, and time targets.

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[1] A work package represents a higher element than the cost account in the work breakdown structure.

PROJECT CONTROL

No sooner is the project launched, control becomes the dominant concern of the project manager. Indeed, once the launch phase is over, planning and control become closely intertwined in an integrated managerial process.

Project control involves a regular comparison of performance against targets, a search for the causes of deviation, and a commitment to check adverse variances. It serves two major functions: (i) it ensures regular monitoring of performance, and (ii) it motivates project personnel to strive for achieving project objectives.

Reasons for Ineffective Control

Effective control is critical for the realisation of project objectives. Yet, control of projects in practice tends to be ineffective. Why? There seems to be three reasons for poor control of projects.

Characteristics of the Project Most of the projects are large, complex undertakings involving many organisations and people. This renders the task of control difficult because:

- Keeping track of physical performance and expenditure on hundreds or thousands (or tens of thousands) of activities which are often non-routine is a stupendous task.
- Coordination and communication problems multiply when several organisations are involved in the project.

People Problems To control a non-routine project, a manager requires an ability to monitor a wide range of disparate factors, a sensitivity to symptoms indicative of potential problems, and a faculty for comprehending the combined effect of multiple forces. Naturally, most of the operational managers, used to the steady rhythm of normal operations and routine work lack the experience, training, competence, and inclination to control projects.

Poor Control and Information System One of the factors which inhibits effective control is the poor quality of control and information system. Some of the weaknesses observed in the control and information system are:

- *Delay in reporting performance* Often there is a delay in the reporting of performance. This prevents effective monitoring of the project and initiation of timely action to check adverse developments.
- *Inappropriate level of detail* Generally cost information for control is collected in terms of cost codes found in the company's cost accounting system, irrespective of the level of detail employed for project planning and budgeting. Consider an extreme example wherein cost and value of work done are reported for the project as a whole. What is the value of such information for identifying where slippages are occurring and who is responsible for them.
- *Unreliable information* One of the major problems in project control is unreliable and inaccurate data and information. Often project managers receive reports which suggest that "everything is okay" or things are "reasonably within control" when the reality is otherwise. Further, for months after the project is completed, costs dribble in to change a favourable variance into an unfavourable one or to aggravate an unfavourable variance.

Variance Analysis Approach

The traditional approach to project control involves a comparison of the actual cost with the budgeted cost to determine the variance. An example of variance analysis is given below:

	Activity A	**Activity B**
Budgeted cost in the period	50,000	30,000
Cumulative budget to date	200,000	75,000
Actual cost in the period	55,000	28,000
Cumulative actual cost to date	240,000	80,000
Variance for the period	(5,000)	2,000
Cumulative variance to date	(40,000)	(5,000)

The variance analysis approach is inadequate for project control for the following reasons:

1. *It is backward looking rather than forward looking* It tells only what happened in the past but does not answer the following questions: What will happen in future? Is the rate of work accelerating or decelerating?
2. *It does not use the data effectively to provide integrated control* The traditional variance analysis shows whether in the time period under analysis more or less resources were expended than budgeted. However, it does not indicate the value of work done. This information is vital for purposes of control.

Performance Analysis: Modern Approach to Control

Effective control over a project requires systematic 'performance analysis'. This calls for answering the following questions:

- Is the project as a whole (and its individual parts) on schedule, ahead of schedule, or behind schedule? If there is a variation, where did it occur, why did it occur, who is responsible for it, and what would be its implications?
- Has the cost of the project as a whole (and its individual parts) been as per budget estimates, less than the budget estimates, or more than the budget estimates? If there is a variation, where did it occur, why did it occur, who is responsible for it, and what would be its implications?
- What is the trend of performance? What would be the likely final cost and completion date for the project and its individual parts?

For small and simple projects, the project managers would do performance analysis for the project as a whole, or for its major components. As the project becomes larger and more complex, performance analysis needs to be done for individual segments of the projects which are referred to as 'cost accounts.' As we have seen earlier, a 'cost account' is a logical management centre.

Method of Analysis For analysing the performance at cost account and higher levels of the work breakdown structure, we employ a method of analysis which takes into account the value of work that has been done. In the traditional method of analysis, the project manager measured the actual progress against the predetermined schedule and the actual cost against the budget estimate. This did not enable him to know systematically whether the expenditure incurred was commensurate with progress. He perhaps relied on subjective estimates.

Performance analysis seeks to remove this subjectivity by employing an analytical framework based on the following terms:

- *BCWS* (Budgeted cost for work scheduled): It represents the total of three components: (i) budgets for all work packages, scheduled to be completed, (ii) budgets for the portion of in-process work, scheduled to be accomplished, and (iii) budgets for the overheads for the period.
- *BCWP* (Budgeted cost for work performed): This is equal to the sum of three components: (i) budgets for work packages actually completed, (ii) budgets applicable to the completed in-process work, and (iii) overhead budgets.
- *ACWP* (Actual cost of work performed): This represents the actual cost incurred for accomplishing the work performed during a particular time period.
- *BCTW* (Budgeted cost for total work): This is simply the total budgeted cost for the entire project work.
- *ACC* (Additional cost for completion): This represents the estimate for the additional cost required for completing the project.

Given the above terms, the project may be monitored along the following lines:

Cost variance : *BCWP – ACWP*
Schedule variance in cost terms : *BCWP – BCWS*
Cost performance index : *BCWP/ACWP*
Schedule performance index : *BCWP/BCWS*
Estimated cost performance index : *BCTW/ (ACWP + ACC)*

Performance Analysis: An Illustration

A project was begun on 1st January 19X0 and was expected to be completed by 30th September 19X0. The project is being reviewed on 30th June 19X0 when the following information has been developed.

			Rs
Budgeted cost for work scheduled	*(BCWS)*	:	1,500,000
Budgeted cost for work performed	*(BCWP)*	:	1,400,000
Actual cost of work performed	*(ACWP)*	:	1,600,000
Budgeted cost for total work	*(BCTW)*	:	2,500,000
Additional cost for completion	*(ACC)*	:	1,200,000

Analysis

Rs

– Cost variance : *BCWP – ACWP* = (1,400,000 – 1,600,000)
= – 200,000

– Schedule variance in cost terms : *BCWP – BCWS* = (1,400,000 – 1,500,000)
= – 100,000

– Cost performance index : *BCWP / ACWP* $= \frac{1,400,000}{1,600,000}$
= 0.8075

– Schedule performance index : *BCWP / BCWS* $= \frac{1,400,000}{1,500,000}$
= 0.933

– Estimated cost performance index : *BCTW/ (ACWP+ACC)* $= \frac{2,500,000}{(1,600,000 + 1,200,000)}$
= 0.893

HUMAN ASPECTS OF PROJECT MANAGEMENT

A satisfactory human relations system is essential for the successful execution of a project. Without such a system, the other systems of project management, however sound they may be by themselves, are not likely to work well. While technical problems can often be solved with additional investment of resources, people's problems may not be amenable to a satisfactory solution in the short span of the project life.

To achieve satisfactory human relations in the project setting, the project manager must successfully handle problems and challenges relating to:

- Authority
- Orientation
- Motivation
- Group functioning

Authority

Except in the divisional organisation, the project manager whose activities cut across functional lines of command, lacks the desired formal authority over project-related personnel. Without the conventional leverage of hierarchial authority, the project manager has to coordinate the efforts of various functional groups (within the organisation) and outside agencies. While he often has formal control emanating from contracts and agreements, as far as outside agencies involved in the project work are concerned, in his own organisation he has to contend with split authority and dual subordination.

Since the project manager works largely with professionals and supervisory personnel, the basis of the authority would be different from that found in simple superior-subordinate relationships. For exercising leadership and influence over professional people, he has to explain the logic and rationale for the project activities; show receptivity to the suggestions made by others; avoid unilateral imposition of decisions; eschew dogmatic postures; and search for areas of agreement which can be the basis of acceptable solutions.

His effective authority would stem from his ability to develop rapport with the project personnel, his skill in resolving conflicts among various people working on the project, his professional reputation and stature, his skills in communication and persuasion, and his ability to act as a buffer between the technical, engineering, financial, and commercial people involved in the project.

Orientation

Most of the managers working for a project are usually engineers (or technologists). Typically, an engineer:

- Works with physical laws, characterised by mathematical precision, as his tools,
- Adopts a structured, mechanical approach to his problems,
- Seeks an enduring solution to his problem,
- Attaches a high value on technical perfection.

When an engineer assumes managerial responsibilities, he faces a very different world in which he is supposed to:

- Perform the tasks of planning, organising, directing, and controlling the resources of the firm in a world of uncertainty.

- Adopt a more creative approach to solve non-programmed and unstructured problems.
- Attach greater importance to efficient utilisation of resources and resolution of human relation problems.

Thus the project manager has to strengthen the managerial orientation of project personnel so that the project goals and objectives can be efficiently achieved within the constraints of time and budget. Clearly for achieving this task he must himself be an accomplished engineer-manager.

Motivation

The project manager functions within the boundaries of a socio-technical system. Most of the factors of this system—organisational structure, technical requirements, competencies of project personnel—are more or less 'given' for him. The principal behavioural factor which he can influence is the motivation of the project personnel. In this context, he should bear in mind the following:

- Human beings are motivated by a variety of needs: physiological needs, social needs, recognition needs, and self-actualisation needs. Individuals differ greatly in the importance they attach to various need satisfactions. Further, their attitudes tend to change with time and circumstances, and are significantly influenced by their peers and superiors.
- The traditional approach to management was based on the assumption that human beings regard work as unpleasant, shirk responsibility, and ordinarily employ inefficient and wasteful methods. Such a conception of human behaviour suggests that a great deal of pressure has to be applied. Behavioural research, however, has shown that while some pressure is beneficial, an excess of it is undesirable. Beyond a certain point, pressure is dysfunctional.
- Motivation tends to be strong when the goal set is challenging, yet attainable. If the goal is too demanding, it results in frustration and conflict; if too lax, it induces complacency.
- Expectation or reward, rather than fear of punishment, has a greater bearing on individual behaviour. Further, the effectiveness of reward or punishment depends on how quickly it is administered.
- In a project setting where hygiene factors (like pay, physical working conditions, etc.) are reasonably taken care of, the principal motivators would be a sense of accomplishment and professional growth. In this setting, the project manager should rely more on participative methods of management.

In order to succeed in motivating project personnel, the project manager must be a perceptive observer of human beings, must have the ability to appreciate the variable needs of human beings, must have skill in several styles of management suitable to different situations, and must be sensitive to the reactions of people so that he can act supportively rather than threateningly.

Understandably, the project manager has a difficult task. In this endeavour, he can, however, count on one blessing: the stimulating and satisfying nature of project work. In established organisations many professional and supervisory personnel find it difficult to see how their efforts redound to the realisation of organisational goals. Separated from top management by several layers of organisational hierarchy, they are unable to relate their work to the missions of the firm (which themselves often may be blurred to them). In addition, the jobs in established organisations are somewhat dull and routine. All this creates a sense of alienation and frustration which dampens motivation. Fortunately, in a project setting, where the superordinate goals are clearly defined and visible to all involved, where there is usually a great emphasis on participative style of management, where the layers in the organisational hierarchy are few, and where the jobs are more challenging, project personnel tend to have greater commitment. Being able to relate their work easily to the goals of the project, their motivation is usually high.

Group Functioning

In a large complex project, many persons drawn from different functions, departments, and organisations are involved. This leads to formation of groups, formal and informal. According to Rensis Likert, organisations may be considered as systems of interlocking groups. Thus, in a typical project organisation, many interlocking and interdependent groups are formed.

The groups formed in a project setting may be of three types; vertical groups, horizontal groups, and mixed groups. A *vertical group* consists of people drawn from different levels in the same department, or function, or company. A *horizontal group* consists of people drawn from different functions, departments, and companies, but occupying similar hierarchical positions. A *mixed group* consists of people drawn from different levels from various functions, departments, and companies.

A vertical group tends to form most naturally because of departmental/functional/organisational affinities. However, the existence of such groups may lead to a pronounced "we/they" attitude and accentuate conflicts. A horizontal group is a useful instrument in linking the overall project organisation. The members of the horizontal group, occupying key positions in their respective fields, serve as channels of communication. By their influence, they can strengthen the commitment to the project. The mixed group tends to promote greater cohesion of the total project organisation. It is very conducive in creating a 'project' attitude and developing an overriding commitment for the project. Hence the project manager should strive to establish a mixed group as the principal group of the project. However, it is difficult to establish such a group because of the temporary nature of a project—when members of a group know that the group would be dissolved sooner or later, they retain strong links with their parent company or department.

Building Effective Groups An effective group consists of members who are satisfied and committed and who strive for the attainment of project objectives, without dissipating their energies in inter-personal and inter-group conflicts. The manifest signs of an effective group are: esprit de corps, pride in the project, supportive behaviour, coordinated endeavour, mutual respect, and resilience during trying periods. An ineffective group, on the other hand, consists of disgruntled members who are more involved in inter-personal and inter-group rivalries and less concerned about project goals. Such a group is characterised by apathy, animosity, mutual bickering, disjointed efforts, cynical attitudes, and low morale.

How can effective groups be established? Studies in group dynamics suggest several stages, which are partially overlapping, in the formation of an effective group:

- Development of mutual trust

- Diminution of defensive behaviour
- Openness and candour in communication
- Cooperation and supportive behaviour
- Resolution of differences by mutual negotiation

For building an effective group, the firm must pursue a genuinely participative style of management. With this managerial philosophy, the project manager can facilitate the development of mutual trust and acceptance, open communication, cooperation, and project attitude. In this task, he needs leadership capabilities, sensitivity to human nature, perceptiveness, concern for welfare of others, maturity, and impartial approach. Clearly this is a difficult and challenging task.

PRE-REQUISITES FOR SUCCESSFUL PROJECT IMPLEMENTATION

Time and cost over-runs of projects are very common in India, particularly in the public sector. The Annual Report of the Ministry of Programme Implementation for a recent year provides some alarming information about 184 central projects monitored by the Ministry of Programme Implementation:

❑ 119 projects (about 65 per cent of the total) have suffered time over-runs, which have gone as high as about 200 per cent—the average delay in commissioning these projects was about 3 years.

❑ 125 projects (about 68 per cent of the total) have suffered cost over-runs, which have been as high as 75 per cent.

❑ Projects for which no time and cost over-runs have been indicated have mostly been taken up recently and it is likely that many of them will also suffer from time and cost over-runs.

A similar analysis of state projects would perhaps reveal an even more dismal picture. Due to such time and cost over-runs, projects tend to become uneconomical, resources are not available to support other projects, and economic development is adversely affected.

What can be done to minimise time and cost over-runs and thereby improve the prospects of successful completion of projects? While a lot of things can be done to achieve this goal, the more important ones appear to be as follows:

- Adequate formulation
- Sound project organisation
- Proper implementation planning
- Advance action
- Timely availability of funds
- Judicious equipment tendering and procurement
- Better contract management
- Effective monitoring.

Adequate Formulation

Often project formulation is deficient because of one or more of the following shortcomings:

- Superficial field investigation
- Cursory assessment of input requirements
- Slip-shod methods used for estimating costs and benefits

- Omission of project linkages
- Flawed judgements because of lack of experience and expertise
- Undue hurry to get started
- Deliberate over-estimation of benefits and under-estimation of costs

Care must be taken to avoid the above deficiencies so that the appraisal and formulation of the project is thorough, adequate, and meaningful.

Sound Project Organisation

A sound organisation for implementing the project is critical to its success. The characteristics of such an organisation are:

- It is led by a competent leader who is accountable for the project performance.
- The authority of the project leader and his team is commensurate with their responsibility.
- Adequate attention is paid to the human side of the project.
- Systems and methods are clearly defined.
- Rewards and penalties to individuals are related to performance.

Proper Implementation Planning

Once the investment decision is taken—and often even while the formulation and appraisal are being done—it is necessary to do detailed implementation planning before commencing the actual implementation. Such planning should, *inter alia*, seek to:

- Develop a comprehensive time plan for various activities like land acquisition, tender evaluation, recruitment of personnel, construction of buildings, erection of plant, arrangement for utilities, trial production run, etc.
- Estimate meticulously the resource requirements (manpower, materials, money, etc.) for each period to realise the time plan.
- Define properly the inter-linkages between various activities of the project.
- Specify cost standards.

Advance Action

When the project appears *prima facie* to be viable and desirable, advance action on the following activities may be initiated: (i) acquisition of land, (ii) securing essential clearances, (iii) identifying technical collaborators/consultants, (iv) arranging for infrastructure facilities, (v) preliminary design and engineering, and (vi) calling of tenders.

To initiate advance action with respect to the above activities, some investment is required. Clearly, if the project is not finally approved, this investment would represent an infructuous outlay. However, the substantial savings (in time and cost) that are expected to occur, should the project be approved (a very likely event, given the *prima facie* desirability of the project) often amply justify the incurrence of such costs.

Timely Availability of Funds

Once a project is approved, adequate funds must be made available to meet its requirements as per the plan of implementation—it would be highly desirable if funds are provided even before the final approval to initiate advance action. Piecemeal, ad-hoc, and niggardly allocation, with undue rigidities, can impair the manoeuverability of the project team. It is a common observation that firms which have a comfortable liquidity position are, in general, able to implement projects expeditiously and economically. Such firms can initiate advance actions vigorously, negotiate with suppliers and contractors aggressively, organise input supplies quickly, take advantages of opportunities to effect economies, support suppliers in resolving their problems so that they can in turn redound to the successful completion of projects, and sustain the morale of project-related personnel at a high level.

Judicious Equipment Tendering and Procurement

To minimise time over-runs, it may appear that a turnkey contract has obvious advantages. Since these contracts are likely to be bagged by foreign suppliers, when global tenders are floated, a very important question arises. How much should we rely on foreign suppliers and how much should we depend on indigenous suppliers? Over-dependence on foreign suppliers, even though seemingly advantageous from the point of view of time and cost, may mean considerable outflow of foreign exchange and inadequate incentive for the development of indigenous technology and capability. Over-reliance on indigenous suppliers may mean delays and higher uncertainty about the technical performance of the project. A judicious balance must be sought which moderates the outflow of foreign exchange and provides reasonable fillip to the development of indigenous technology. In any case, the number of contract packages should be kept to a minimum in order to ensure effective coordination.

Better Contract Management

Since a substantial portion of a project is typically executed through contracts, the proper management of contracts is critical to the successful implementation of the project. In this context, the following should be done:

- The competence and capability of all the contractors must be ensured—one weak link can jeopardise the timely performance of the contract.
- Proper discipline must be inculcated among contractors and suppliers by insisting that they should develop realistic and detailed resource and time plans which are congruent with the project plan.
- Penalties—which may be graduated—must be imposed for failure to meet contractual obligations. Likewise, incentives may be offered for good performance.
- Help should be extended to contractors and suppliers when they have genuine problems—they should be regarded as partners in a common pursuit.
- Project authorities must retain latitude to off-load contracts (partially or wholly) to other parties well in time where delays are anticipated.

Effective Monitoring

In order to keep a tab on the progress of the project, a system of monitoring must be established. This helps in:

- Anticipating deviations from the implementation plan
- Analysing emerging problems
- Taking corrective action

In developing a system of monitoring, the following points must be borne in mind:

- It should focus sharply on the critical aspects of project implementation.
- It must lay more emphasis on physical milestones and not on financial targets.
- It must be kept relatively simple. If made over-complicated, it may lead to redundant paper work and diversion of resources. Even worse, monitoring may be viewed as an end in itself rather than as a means to implement the project successfully.

SUMMARY

- The traditional form of organisation is not very suitable for project work because it has no means of integrating different departments at levels below the top management and it does not facilitate effective communication, coordination, and control.
- Project organisation may take one of the following three forms: line and staff organisation, divisional organisation, and matrix organisation.
- In the line and staff form of project organisation, a person is appointed with the primary responsibility of coordinating the work of the people in the functional departments. Under the divisional form of project organisation, a separate division headed by the project manager is set up to implement the project. In a matrix organisation, the personnel working on the project have a responsibility to their functional superior as well as to the project manager.
- The line and functional form of organisation is conducive to an efficient use of resources but is not suitable for an effective realisation of project objectives. The divisional form of organisation, on the other hand, is suitable for an effective realisation of project objectives but not conducive to an efficient use of resources. The matrix form of organisation seeks to achieve the twin objectives of efficient use of resources and effective realisation of project objectives, at the cost of greater organisational complexity, of course.
- Comprehensive project planning covers the following areas: project work, manpower and organisation, money, and information systems.
- The important stages in the lifecycle of a project are: project development and preliminary engineering, bidding and contract negotiation, engineering design, purchase and procurement, construction, and commissioning.
- The two important tools of planning are the bar chart and the network techniques. The bar chart is a pictorial device in which the activities are represented by horizontal bars on the time axis. In network techniques, the activities, events, and their inter-relationships are represented by a network diagram.
- For large projects, a hierarchy of plans showing various levels of detail may be prepared.
- The traditional approach to project control, involving a comparison of the actual cost with the budgeted cost, is referred to as variance analysis. This approach is inadequate for project control for the following reasons: (i) it is backward-looking rather than forward-looking, and (ii) it does not use the data effectively to provide integrated control.
- The modern approach to project control, referred to as performance analysis, involves monitoring the project along the following lines:

Cost variance : Budgeted cost of work performed – Actual cost of work performed.

Schedule variance in cost terms : Budgeted cost of work performed – Budgeted cost of work scheduled.

Cost performance index : Budgeted cost of work performed/Actual cost of work scheduled.

Schedule performance index : Budgeted cost of work performed/Budgeted cost of work scheduled.

Estimated cost performance index : Budgeted cost for total work/(Actual cost of work performed + Additional cost for completion).

- To achieve satisfactory human relations in the project setting, the project manager must successfully handle problems and challenges relating to (i) authority, (ii) orientation, (iii) motivation, and (iv) group functioning.
- Often, the project manager has to coordinate the efforts of various functional groups (within the organisation) and outside agencies without the leverage of hierarchical authority. His effective authority depends largely on his professional stature and inter-personal skills.
- The project manager has to strengthen the managerial orientation of project personnel, particularly technical and engineering personnel.
- In order to succeed in motivating personnel, the project manager must be a perceptive observer of human beings, must have the ability to appreciate the variable needs of human beings, must have a skill in several styles of management suitable to different situations, and must be sensitive to the reactions of people so that he can act supportively rather than threateningly.
- There are several stages, partially overlapping, in the formation of an effective group: development of mutual trust, diminution of defensive behaviour, openness and candour in communication, cooperation and supportive behaviour, and resolution of differences by mutual negotiation.
- Time and cost over-runs of projects are very common in India, particularly in the public sector. Hence, projects tend to become uneconomical and economic development is adversely affected.
- The important pre-requisites for successful completion of projects are: (i) adequate formulation, (ii) sound project organisation, (iii) proper implementation planning, (iv) advance action, (v) timely availability of funds, (vi) judicious equipment tendering and procurement, (vii) better contract management, and (viii) effective monitoring.

QUESTIONS

1. "The traditional form of organisation is not suitable for the management of projects". Comment.
2. Describe and evaluate the various forms of project organisation.
3. What is a bar chart? What are its advantages and limitations?
4. Discuss the notion of hierarchy of plans.
5. Why does the control of projects in practice tend to be ineffective?

6. Discuss and evaluate the variance analysis approach to project control.
7. What is 'performance analysis'? What are the dimensions along which monitoring is done in 'performance analysis'?
8. Discuss the authority and orientation problems in a project setting.
9. What considerations should the project manager bear in mind with respect to motivation of the project personnel?
10. What types of groups may be formed in a project setting?
11. What is an effective group? What are the stages in the formation of an effective group?
12. Discuss the pre-requisites for successful project implementation.

PROBLEMS

1. A project has begun on 1st April 19x5 and was expected to be completed by 31st December 19x5. The project is being reviewed on 30th September 19x5 when the following information has been developed:

    - Budgeted cost for work scheduled (BCWS) : Rs 6,000,000
    - Budgeted cost for work performed (BCWP) : Rs 5,500,000
    - Actul cost of work performed (ACWP) : Rs 5,800,000
    - Budgeted cost for total work (BCTW) : Rs 10,000,000
    - Additional cost for completion (ACC) : Rs 5,000,000

    Determine the following: (i) cost variance, (ii) schedule variance in cost terms, (iii) cost performance index, (iv) schedule performance index, and (v) estimated cost performance index.

19

Network Techniques for Project Management

Once a project is selected, the focus shifts to its implementation. This involves the completion of numerous activities (project components) by employing various resources—men, materials, machine, money, and time—so that a project on paper is translated into concrete reality.

The activities of a project have inter-relationships arising from physical, technical, and other considerations. For proper planning, scheduling, and control of the activities of a project, given their inter-relationships and constraints on the availability of resources, network techniques have been found quite useful. It may be noted that financial institutions and the Government of India insist that a network plan should accompany feasibility reports.

There are two basic network techniques: PERT and CPM. PERT, an acronym for *Program Evaluation Review Technique*, was originally developed to facilitate the planning and scheduling of the Polaris Fleet Ballistic Missile Project of the U.S. government. Designed to handle risk and uncertainty, PERT is eminently suitable for research and development programmes, aerospace projects, and other projects involving new technology. In such projects the time required for completing various jobs or activities can be highly variable. Hence the orientation of PERT is 'probabilistic'.

CPM, an acronym for *Critical Path Method*, is akin to PERT. It was developed independently in 1956-57 by the Du Pont Company in the U.S. to solve scheduling problems in industrial settings. CPM is primarily concerned with the trade-off between cost and time. It has been applied mostly to projects that employ a fairly stable technology and are relatively risk free. Hence its orientation is 'deterministic'.

Widely diverse projects are amenable to analysis by PERT and CPM. Here is an illustrative list.

- Launching a spaceship
- Research and development programme
- Construction of a plant
- Building a river valley project
- Overhaul of an organisation
- Training of manpower

- Starting a new venture
- Adult literacy programme

The common characteristics of the above projects which make them amenable to analysis by PERT or CPM are:

1. The project can be broken down into a well-defined set of jobs or activities.
2. The activities must be performed in a certain sequence which is technologically ordered.
3. Within a defined sequence, the activities may be started and stopped in an independent manner.

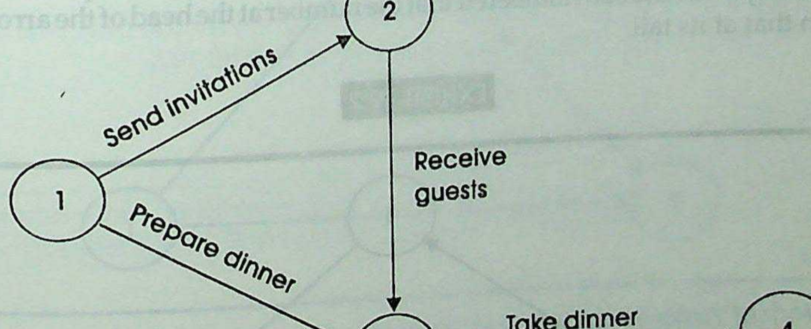
This chapter discusses the basics of PERT, CPM, and network cost system. It is organised into seven sections.

- Development of project network
- Time estimation
- Determination of critical path
- Scheduling when resources are limited
- PERT model
- CPM model
- Network cost system

DEVELOPMENT OF PROJECT NETWORK

Basic to PERT as well as CPM is the network diagram. The network diagram, also referred to as the project graph, shows the activities and events of the project and their logical relationships. A simplified network diagram for a dinner project is shown in Exhibit 19.1

EXHIBIT 19.1



The network diagram is constructed in terms of activities and events. An activity is a definite task, job, or function to be performed in a project. For example, 'prepare dinner' (see Exhibit 19.1) is an activity. An activity is represented by an arrow. The head of the arrow marks the completion of the activity and the tail of the arrow marks its beginning. (The length and 'compass' direction of the arrow have no significance.) An event is a specific point in time indicating the beginning or end of one or more activities. It represents a milestone and does not consume time or resources. For example, event 2 in Exhibit 19.1 marks completion of the activity 'send invitation.'

Since activities are the basic building blocks of a network diagram, it is necessary to enumerate all the activities of the project. For this purpose, it is helpful to break the project in several steps. The number of steps, of course, would depend on the magnitude and complexity of the project. For industrial projects generally a two-step procedure would suffice. In the first step, the major parts of the project are identified and in the second step the activities of each major part are delineated. Activities should be so defined that they are distinct, reasonably homogeneous tasks for which time and resource requirement can be estimated.

Once the activities are enumerated it is necessary to define for each activity, the activities which precede it, the activities which follow it, and the activities which can take place concurrently. Given this information, the network diagram, showing the logical relationship between activities and events may be developed following either the forward method or the backward method.

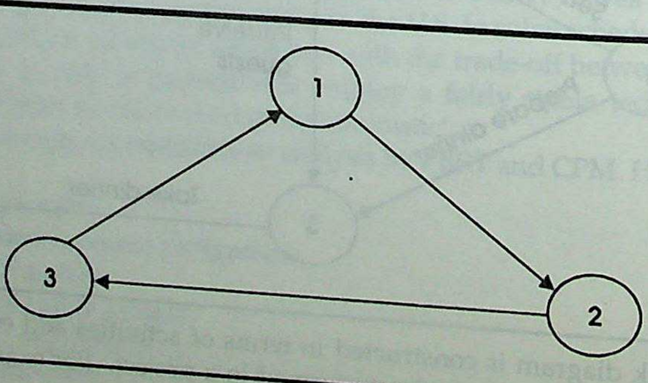
The forward method begins with the initial event, marking the beginning of the project, and proceeds forward till the end event is reached. The backward method begins with the end event and works backwards till the beginning event is reached.

Rules for Network Construction

The rules to be observed in constructing the network diagram are discussed below:

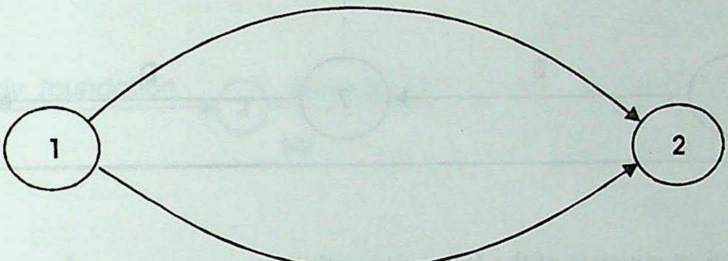
1. Each activity must have a preceding and a succeeding event. An activity is numerically denoted by the pair of preceding and succeeding events. In the dinner project, for example, the activity 'send invitations' is designated as (1-2).
2. Each event should have a distinct number. The number given to an event can be chosen in any way, provided this condition is satisified. In practice, however, normally events are so numbered that the number at the head of the arrow is greater than that at its tail.

EXHIBIT 19.2



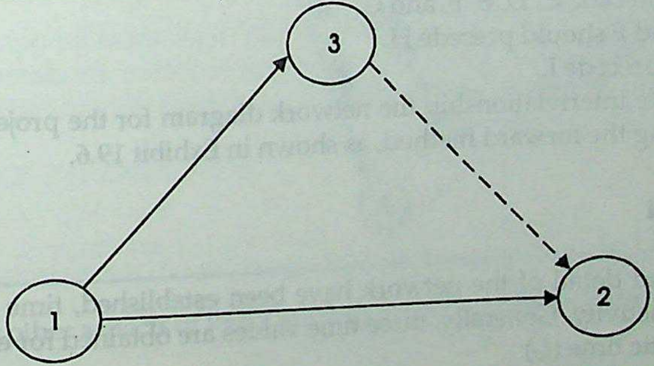
3. There should be no loops in the project network. A situation like the one shown in Exhibit 19.2 is not permissible.
4. Not more than one activity can have the same preceding and succeeding events. This means that each activity is represented by a uniquely numbered arrow and a situation like the one shown in Exhibit 19.3 is not permissible.

EXHIBIT 19.3



To ensure that each activity is uniquely numbered it may be necessary sometimes to introduce dummy activities. A dummy activity is an imaginary activity which can be accomplished in zero time and which does not consume resources. It is represented by a dashed arrow. Exhibit 19.4 shows a variant of Exhibit 19.3 with a dummy activity (3-2) introduced to conform to the rules of network construction.

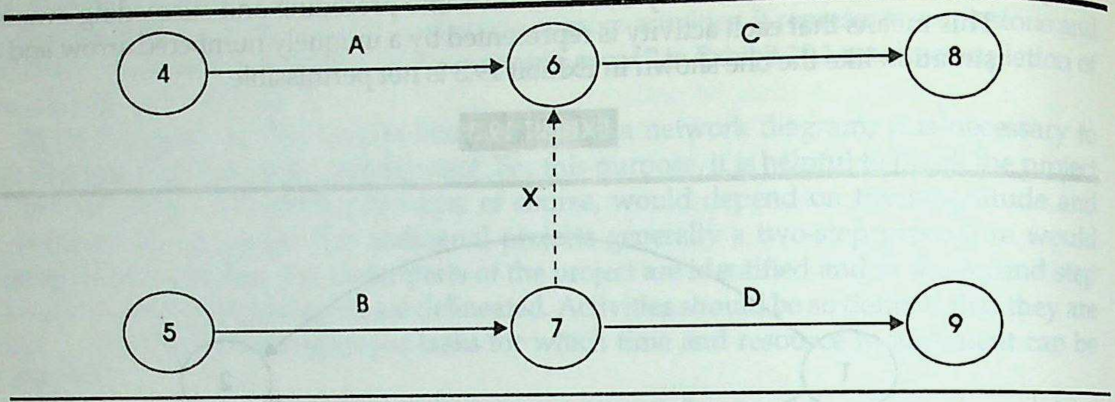
EXHIBIT 19.4



A dummy activity may also be used to represent a constraint necessary to show the proper relationship between activities. Exhibit 19.5 shows part of a network diagram having a dummy activity.

In Exhibit 19.5, *X*, represented as (7-6), is a dummy activity showing a certain logical relationship. According to this figure, activities *A* (4-6) and *B* (5-7) must be completed before activity *D* (6-8) can start.

EXHIBIT 19.5



Illustration

A building project consists of the following activities:

A = Lay foundation
B = Erect framework
C = Install millwork
D = Install wiring
E = Install plumbing
F = Plaster walls
G = Install siding
H = Decorate the interior
I = Finish the exterior

The interrelationship among these activities is as follows:

1. A should precede B.
2. B should precede C, D, E, F, and G.
3. C, D, E, and F should precede H.
4. G should precede I.

Given the above interrelationship the network diagram for the project is developed, in several steps, using the forward method, as shown in Exhibit 19.6.

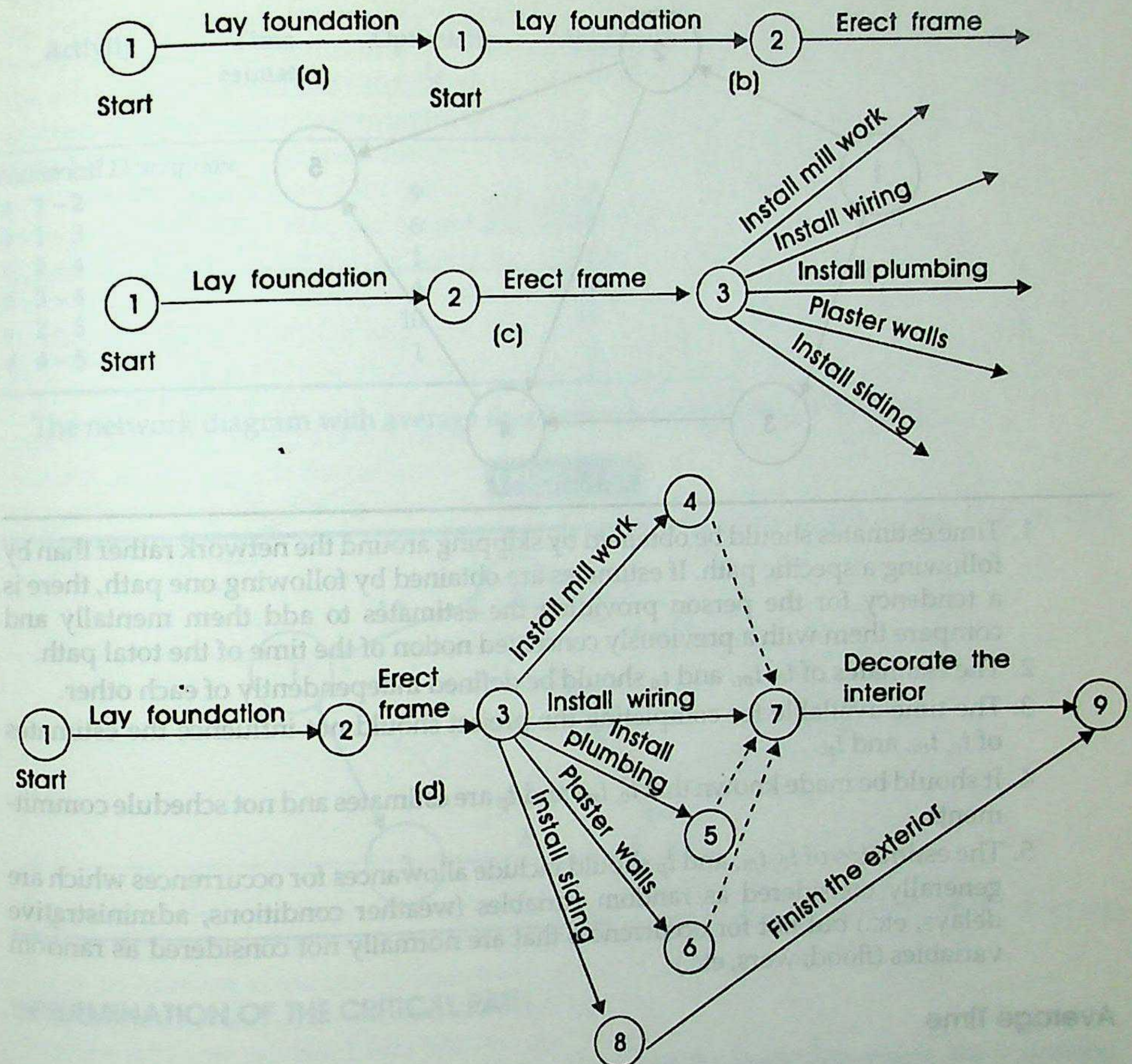
TIME ESTIMATION

Once the logic and detail of the network have been established, time estimates must be assigned to each activity. Generally, three time values are obtained for each activity:

1. Optimistic time (t_o)
2. Most likely time (t_m)
3. Pessimistic time (t_p)

The optimistic time, t_o, is the time required if no hurdles or complications arise. The most likely time, t_m, is the time in which the activity is most likely to be completed. This estimate takes into consideration normal circumstances, making allowance for some unforeseen delays. The pessimistic time, t_p, is the time required if unusual complications and/or unforeseen difficulties arise.

EXHIBIT 19.6

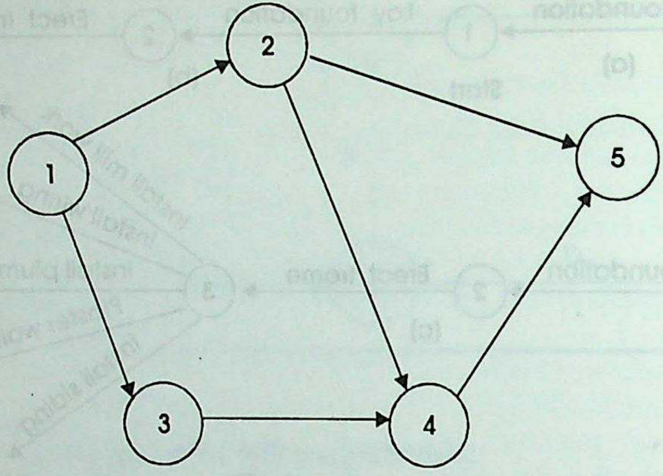

1
Start
Lay foundation
(a)
1
Start
Lay foundation
2
Erect frame
(b)
1
Start
Lay foundation
2
Erect frame
(c)
3
Install mill work
Install wiring
Install plumbing
Plaster walls
Install siding
1
Start
Lay foundation
2
Erect frame
(d)
3
Install mill work
4
Install wiring
Install plumbing
Plaster walls
Install siding
5
6
7
8
Decorate the interior
Finish the exterior
9

For discussing other aspects of PERT analysis a simple project shown in Exhibit 19.7 shall be used.

Obtaining Time Estimates

Time estimates should be obtained by the PERT planner from persons who are responsible for estimation. The following points should be borne in mind while obtaining time estimates:

EXHIBIT 19.7



1. Time estimates should be obtained by skipping around the network rather than by following a specific path. If estimates are obtained by following one path, there is a tendency for the person providing the estimates to add them mentally and compare them with a previously conceived notion of the time of the total path.
2. The estimates of t_o, t_m, and t_p should be defined independently of each other.
3. The time available for completing the project should not influence the estimates of t_o, t_m, and t_p.
4. It should be made known that t_o, t_m, and t_p are estimates and not schedule commitments.
5. The estimates of t_o, t_m, and t_p should include allowances for occurrences which are generally considered as random variables (weather conditions, administrative delays, etc.) but not for occurrences that are normally not considered as random variables (flood, wars, etc.)

Average Time

Once the three time estimates for each activity are obtained, the expected value of activity durations is calculated. The expected value, t_e, is usually obtained by the formula:

$$t_e = \frac{t_o + t_m + t_p}{6} \tag{19.1}$$

where t_e = weighted arithmetic average time
t_o = optimistic time
t_m = most likely time
t_p = pessimistic time

The time estimates for various activities in our illustrative project are shown in Exhibit 19.8.

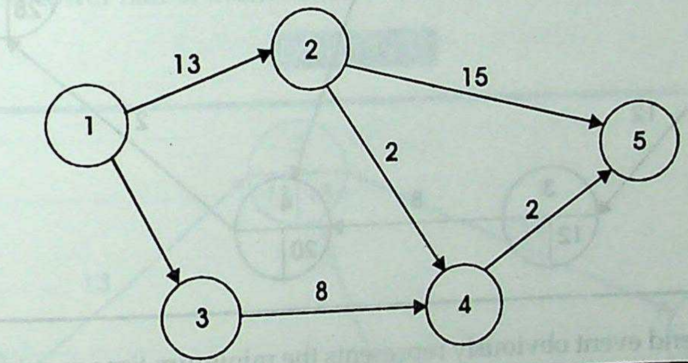
EXHIBIT 19.8

Time Estimates

Activity	Time esimate			
	Optimistic t_e	Most likely t_m	Pessimistic t_p	Average $t_e = \frac{t_o + 4t_m + t_p}{6}$
Numerical Description				
a 1 – 2	9	12	21	13
b 1 – 3	6	12	18	12
c 2 – 4	1	1.5	5	2
d 3 – 4	4	8.5	10	8
e 2 – 5	10	14	24	15
d 4 – 5	1	2	3	2

The network diagram with average time estimates is shown in Exhibit 19.9.

EXHIBIT 19.9



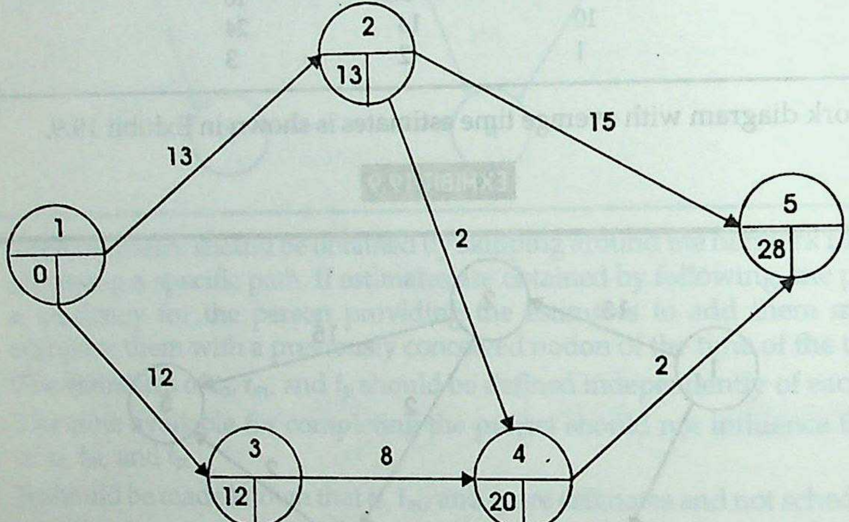
DETERMINATION OF THE CRITICAL PATH

Once the network diagram with single time estimates has been developed, the following computational procedure may be employed for determining the critical path/s, event slacks, and activity floats.

1. *Calculate the earliest occurrence time (EOT) for each event.*
   An event occurs when all activities leading to the event have been completed. In the network diagram shown in Exhibit 19.9, for example, event 4 occurs when activities (2–4) and (3–4) are completed. Obviously activity (2–4) cannot begin unless event 2 occurs, which in turn requires the completion of activity (1–2). Likewise, activity (3–4) cannot begin unless event 3 occurs which in turn requires the completion of activity (1–3). Thus we find that event 4 occurs when activities (1–2), (2–4), (1–3), and (3–4) are completed. In other words, event 4 occurs when paths (1–2–4) and (1–3–4) are completed.

The *EOT* of an event refers to the time when the event can be completed at the earliest. Looking at event 4 we find that since the paths leading to it, viz., (1–2–4) and (1–3–4) take 15 weeks and 20 weeks, respectively, the *EOT* of event 4 is 20 weeks. In general terms, the *EOT* of an event is the duration of the longest path (from the beginning event whose *EOT* is set at 0) leading to that event. The *EOT*s of various events in our illustrative project are shown in Exhibit 19.10. It may be noted that in Exhibit 19.10 and subsequent figures an event is represented by a circle. The upper half of the circle denotes the event number, the left quarter in the lower half denotes the *EOT*, and the right quarter in the lower half denotes the latest occurrence time, a term described later.

EXHIBIT 19.10



The *EOT* of the end event obviously represents the minimum time required for completing the project. To obtain the *EOT* of various events we start from the beginning event and move forward towards the end event. This computational procedure is referred to as the forward pass. In this computation we assume that each activity starts immediately on the occurrence of the event preceding it. Hence the starting and finishing time for various activities obtained from this computation are the earliest starting time (*EST*) and the earliest finishing time (*EFT*).

The general formula for *EOT* is :

$$EOT\,(i) = \text{Max}\,[\,EOT\,(k) + d\,(k, i)\,] \tag{19.2}$$

where $EOT\,(i)$ = earliest occurrence time of event i

$EOT\,(k)$ = earliest occurrence time of event k (k precedes i and there may be several k's)

$d\,(k, i)$ = duration of activity (k, i).

The maximisation shown is done considering all activities (k, i) leading to event node i.

The formulae for *EST* and *EFT* are :

$$EST\,(i, j) = EOT\,(i) \tag{19.3}$$

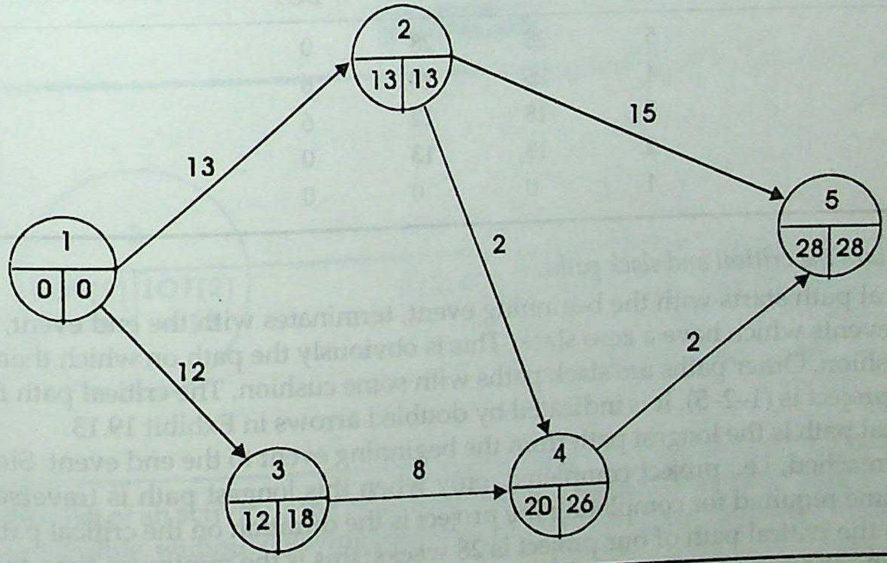
$$EFT(i, j) = EOT(i) + d(i, j) \tag{19.4}$$

where $EST(i, j)$ = earliest starting time for activity (i, j)
$EOT(i)$ = earliest occurrence time of event (i)
$EFT(i, j)$ = earliest finishing time for activity (i, j)
$d(i, j)$ = duration of activity (i, j)

2. *Calculate the latest occurrence time (LOT) for each event.*

The *LOT* for an event represents the latest allowable time by which the event can occur, given the time that is allowed for the completion of the project (occurrence of end event). Normally, the time allowed for the completion of the project is set equal to the *EOT* of the end event. (In other words, the project is supposed to be completed at the earliest possible time.) This means that for the end event the *LOT* and *EOT* are set equal. The *LOT* for various events is obtained by working backward from the end event. This procedure is known as the backward pass. The *LOT* for event 4 in our illustrative project, for example, is equal to the *LOT* for event 5, the end event, minus the duration of the activity (4–5) which connects event 4 with 5. Since the *LOT* for event 5 is 28 weeks and the duration of activity (4–5) is 2 weeks the *LOT* for event 4 is 26 weeks (28–2). This represents the latest time by which event 4 should occur to enable the project to be completed in 28 weeks. Likewise, the *LOT* for other events can be calculated by moving backward. The *LOT* for various events is shown (in the right quarter of the lower half of event nodes) in Exhibit 19.11.

EXHIBIT 19.11



The general formula for *LOT* is:

$$LOT(i) = \text{Min}\,[\,LOT(j) - d(i, j)\,] \tag{19.5}$$

where $LOT(i)$ = latest occurrence time for i
$LOT(j)$ = latest occurrence time for j
(j follows i and there may be several j's)

$d(i,j)$ = duration of activity (i,j).
The minimisation shown here is done with respect to all activities (i,j) starting from i.

Given the *LOT* for various events we can calculate the latest finishing time (*LFT*) and latest starting time (*LST*) for various activities using the formulae:

$$LFT(i,j) = LOT(j) \tag{19.6}$$

$$LST(i,j) = LFT(i,j) - d(i,j) \tag{19.7}$$

where $LFT(i,j)$ = latest finishing time for activity (i,j)
$LOT(j)$ = latest occurrence time for event j
$LST(i,j)$ = latest starting time for activity (i,j)
$d(i,j)$ = duration of activity (i,j)

3. *Calculate the slack for each event.*

The slack for an event is the difference between its *LOT* and *EOT*. The slacks for various events of our illustrative project are shown in Exhibit 19.12.

EXHIBIT 19.12

Event Slack (in weeks)

Event	*LOT*	*EOT*	Slack = *LOT* − *EOT*
5	28	28	0
4	26	20	6
3	18	12	6
2	13	13	0
1	0	0	0

4. *Obtain the critical and slack paths.*

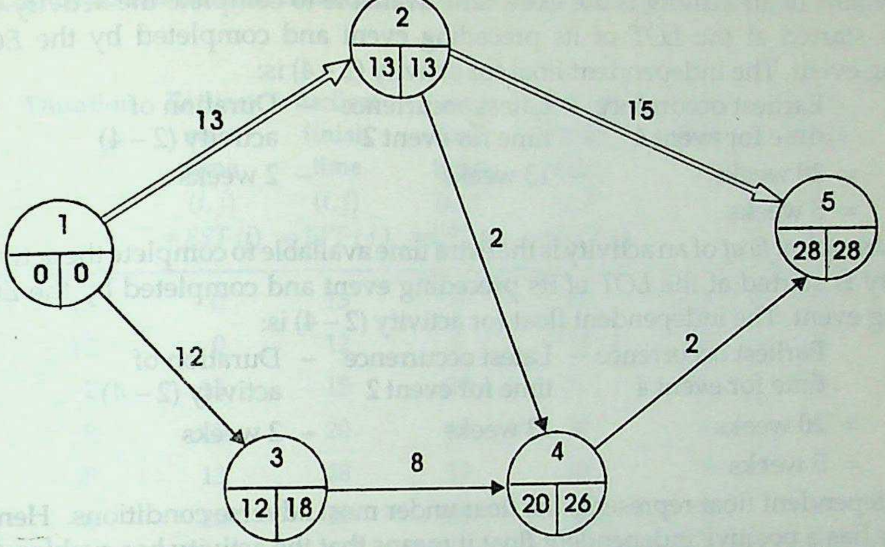
The critical path starts with the beginning event, terminates with the end event, and is marked by events which have a zero slack. This is obviously the path on which there is no slack, no cushion. Other paths are slack paths with some cushion. The critical path for our illustrative project is (1–2–5). It is indicated by doubled arrows in Exhibit 19.13.

The critical path is the longest path from the beginning event to the end event. Since the end can be reached, i.e., project completed, only when this longest path is traversed, the minimum time required for completing the project is the duration on the critical path. The duration on the critical path of our project is 28 weeks; this is the minimum time required for completing the project. (It is already indicated by the *EOT* of event 5, the end event.)

5. *Compute the activity floats.*

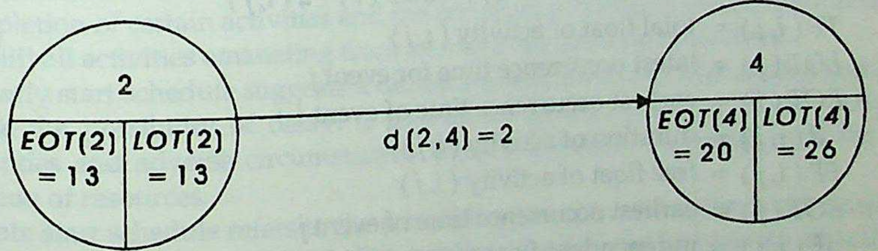
Given the estimates of activity time and event slacks, activity floats can be calculated. There are three measures of float: (i) total float; (ii) free float; and (iii) independent float. For illustrating these measures let us consider activity (2-4) of our illustrative project. Activity (2–4) is shown in Exhibit 19.14.

EXHIBIT 19.13



In Exhibit 19.14 *EOT*, *LOT*, and *d* represent respectively, earliest occurrence time, latest occurrence time, and duration.

EXHIBIT 19.14



The *total float* of an activity is the extra time available to complete the activity if it is started as early as possible, without delaying the completion of the project. The total float for activity (2–4) is equal to :

Latest occurrence time for event 4 – Earliest occurrence time for event 2 – Duration of activity (2 – 4)
= 26 weeks – 13 weeks – 2 weeks
= 11 weeks

The *total float* represents float under most favourable conditions. This is so because the activity can be started at the earliest (the *EOT* of the preceding event) and completed at the latest (the *LOT* of its succeeding event). Obviously, activities which do not have a float even under these conditions, the most favourable ones, are critical to the project and hence lie on the critical path.

The *free float* of an activity is the extra time available to complete the activity when the activity is started at the *LOT* of its preceding event and completed by the *EOT* of its succeeding event. The independent float for activity (2 – 4) is:

Earliest occurrence time for event 4 – Latest occurrence time for event 2 – Duration of activity (2 – 4)
= 20 weeks – 13 weeks – 2 weeks
= 5 weeks

The *independent float* of an activity is the extra time available to complete the activity when the activity is started at the *LOT* of its preceding event and completed by the *EOT* of its succeeding event. The independent float for activity (2 – 4) is:

Earliest occurrence time for event 4 – Latest occurrence time for event 2 – Duration of activity (2 – 4)
= 20 weeks – 13 weeks – 2 weeks
= 5 weeks

The independent float represents the float under most adverse conditions. Hence when an activity has a positive independent float it means that the activity has cushion (equal to its independent float) irrespective of what happens elsewhere. (It may be noted that the independent float of an activity may be negative but the total float and free float cannot be negative.)

More generally, floats may be represented by the following equations:

$$TF(i,j) = LOT(j) - EOT(i) - d(i,j) \tag{19.8}$$

$$FF(i,j) = EOT(j) - EOT(i) - d(i,j) \tag{19.9}$$

$$IF(i,j) = EOT(j) - LOT(i) - d(i,j) \tag{19.10}$$

where $TF(i,j)$ = total float of activity (i,j)
$LOT(j)$ = latest occurrence time for event j
$EOT(i)$ = earliest occurrence time of event i
$d(i,j)$ = duration of activity (i,j)
$FF(i,j)$ = free float of activity (i,j)
$EOT(j)$ = earliest occurrence time of event j
$IF(i,j)$ = independent float of activity (i,j)
$LOT(j)$ = latest occurrence time of event i

The floats for various activities of our illustrative project are shown in Exhibit 19.15.

SCHEDULING WHEN RESOURCES ARE LIMITED

From Exhibit 19.15, we find that critical activities (1–2) and (2–5) have no float associated with them. This means that there is no flexibility whatsoever in scheduling these activities —the earliest starting time is the same as the latest starting time and the earliest finishing time is the same as the latest finishing time. For non-critical activities, however, some float is available and this provides flexibility in scheduling them. The choice available in this respect is bounded by two schedules: the early start schedule and the late start schedule.

EXHIBIT 19.15

Activity Floats

(in weeks)

Activity (*i*, *j*)	Duration	Earliest start time (*i*, *j*) = *EST* (*i*)	Earliest finish time (*i*, *j*) = *EFT* (*j*)	Latest start time (*i*, *j*) = *LST* (*i*)	Latest finish time (*i*, *j*) = *LFT* (*j*)	Total float	Free float	Independent float
a (1–2)	13	0	13	0	13	0	0	0
b (1–3)	12	0	12	6	18	6	0	0
c (2–4)	2	13	15	24	26	11	5	5
d (3–4)	8	12	20	18	26	6	0	(6)
e (2–5)	15	13	28	13	28	0	0	0
f (4–5)	2	20	22	26	28	6	6	0

The Bounding Schedules: Early Start Schedule and Late Start Schedule

The early start schedule refers to the schedule in which all activities start as early as possible. In this schedule (i) all events occur at their earliest because all activities start at their earliest starting time and finish at their earliest finishing time, (ii) there may be time lags between the completion of certain activities and the occurrence of events which these activities lead to; and (iii) all activities emanating from an event begin at the same time.

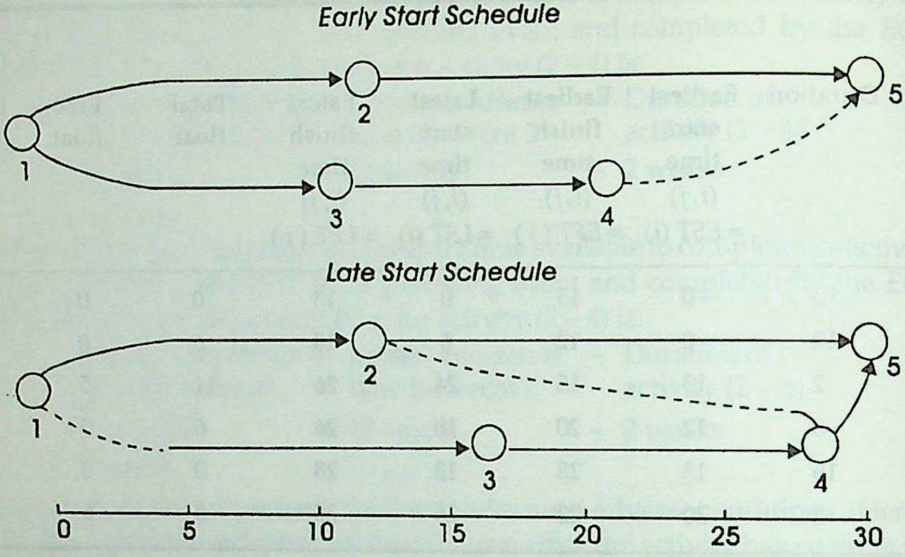
The early start schedule suggests a cautious attitude towards the project and a desire to minimise the possibility of delay. It provides a greater measure of protection against uncertainties and adverse circumstances. Such a schedule, however, calls for an earlier application of resources.

The late start schedule refers to the schedule arrived at when all activities are started as late as possible. In this schedule (i) all events occur at their latest because all activities start at their latest finishing time; (ii) some activities may start after a time lag subsequent to the occurrence of the preceding events; and (iii) all activities leading to an event are completed at the same time.

The late start schedule reflects a desire to commit resources late—as late as possible. However, such a schedule provides no elbow room in the wake of adverse developments. Any unanticipated delay results in increased project duration.

The early start schedule and the late start schedule for our illustrative project are shown in Exhibit 19.16. Here the project schedules are shown as graphs with a horizontal time scale.

EXHIBIT 19.16



Choice of a Schedule in View of Resource Constraints

In our discussion so far we assumed that any schedule which is technologically feasible—which does not violate the logical relationship among activities as shown in the network diagram—can be adopted. For generating various schedules, the early start schedule, the late start schedule, or any other schedule lying between these two bounds, information was required only regarding network logic and activity durations.

This approach to scheduling implicitly assumes that adequate resources are available so that each activity can be scheduled anywhere between its earliest starting time and latest starting time. In real life situations, however, there may be restrictions on the availability of resources. For example, manpower supply may be limited or funds made available period-wise may be rigidly budgeted. When restrictions exist various schedules may have to be considered to find out which one is most appropriate in the light of these restrictions. We shall discuss two examples to indicate the broad approach to scheduling in the face of resource constraints.

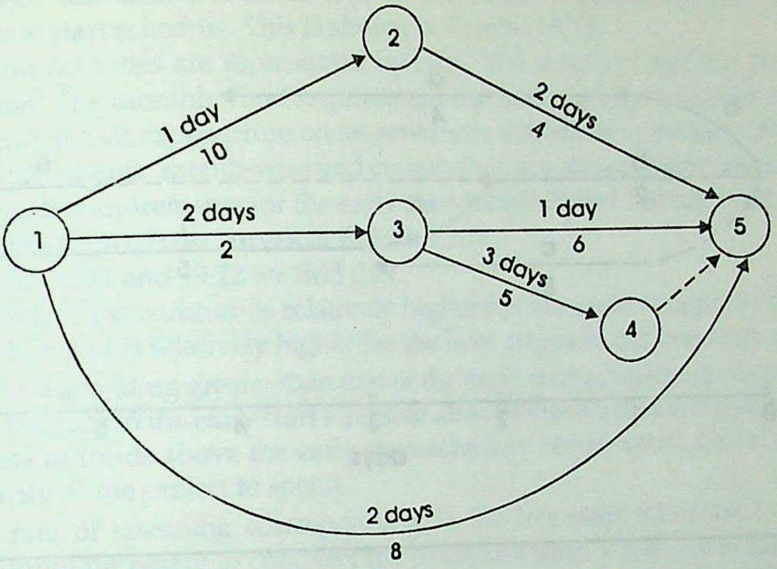
Example 1: Scheduling to Match Availability of Manpower

Let us consider a small project for which the network diagram is shown in Exhibit 19.17.

In Exhibit 19.17 activity duration is shown above the activity arrow and manpower requirement is shown below the activity arrow. Only 12 men are available for the project (a manpower resource constraint). The early start schedule of this project is shown as a graph on the horizontal time scale in Exhibit 19.18.

Looking at the manpower requirement for the early start schedule we find that it is 20 for the first day, 14 for the second day, 15 for the third day, 5 for the fourth day, and 5 for the

EXHIBIT 19.17


1
2
3
4
5
1 day
10
2 days
4
2 days
2
1 day
6
3 days
5
2 days
8

fifth day. Obviously, this schedule is unacceptable in view of the manpower constraint. So, we explore the possibility of shifting activities. Our efforts at shifting activities, keeping the project duration at five days, soon reveals that no schedule is feasible with only 12 men. So we extend the duration of the project by one day and try various schedules to see whether we can find a feasible schedule. A little juggling of activities shows that a schedule like the one shown in Exhibit 19.19 is feasible—this is the best we can do.

EXHIBIT 19.18

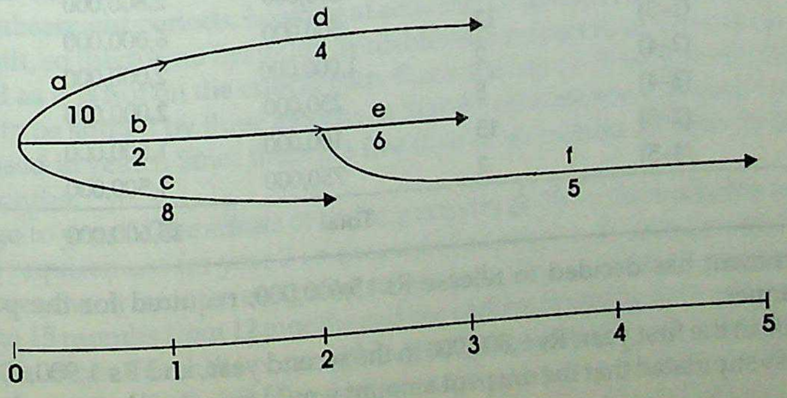
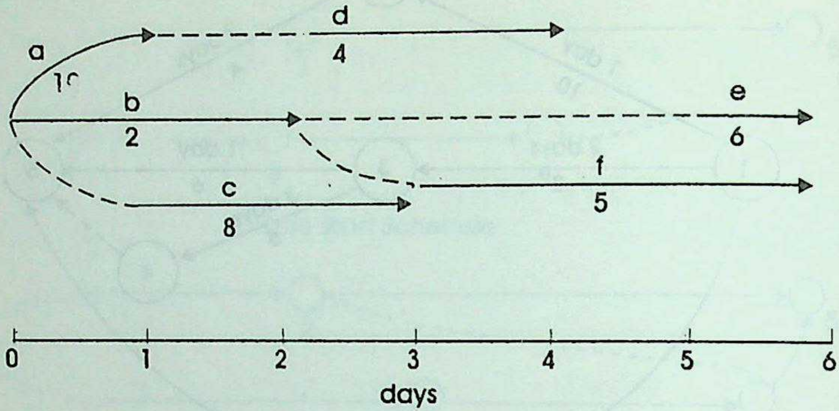

d
4
a
10
b
2
e
6
f
5
c
8
0
1
2
3
4
5

EXHIBIT 19.19



Example 2: Scheduling to Match the Release of Funds

The cost estimates for various activities of our illustrative project (see Exhibit 19.8) are given in Exhibit 19.20. For our discussion here, *weeks* have been changed to *months*.

EXHIBIT 19.20

Cost Estimates

Activity	Duration in months	Cost per month		Cost
		Rs		Rs
(1–2)	13	200,000		2,600,000
(1–3)	12	500,000		6,000,000
(2–4)	2	1,000,000		2,000,000
(3–4)	8	250,000		2,000,000
(2–5)	15	100,000		1,500,000
(4–5)	2	750,000		1,500,000
		Total	=	15,600,000

The government has decided to release Rs 15,600,000, required for the project, in the following manner:

Rs 6,900,000 in the first year; Rs 6,800,000 in the second year, and Rs 1,900,000 in the third year. It has also stipulated that the unspent amount would lapse and hence cannot be carried forward.

Before we develop the project schedule, a preliminary question may be asked: Is it possible *prima facie* to schedule this project without extending its duration beyond 28 months, which is the minimum time required given the network logic and activity durations? To answer this question let us look at the funds requirement for the early start schedule and late start schedule. This is shown in Exhibit 19.21.

In this exhibit activities are represented by bars. The length of the bar corresponds to activity duration. The monthly fund requirement for each activity is shown above its bar. (Here it is assumed that expenditure on an activity is uniformly spread over its duration.) The project requirements, month-wise and cumulative, are shown along the time axis. The cumulative project requirements for the early start schedule and the late start schedule are also shown in the form of cost curves in Exhibit 19.22.

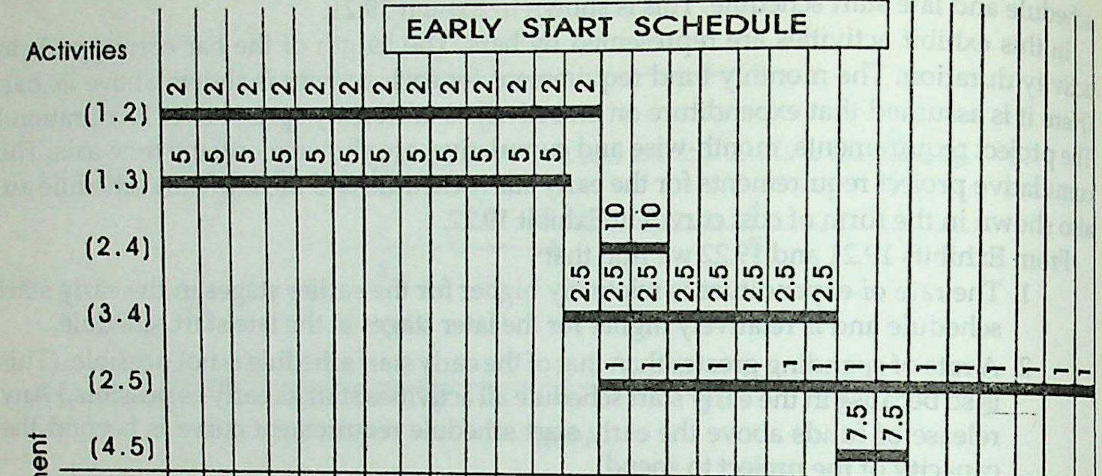
From Exhibits 19.21 and 19.22 we find that:

1. The rate of expenditure is relatively higher for the earlier stages in the early start schedule and is relatively higher for the later stages in the late start schedule.
2. A rate of spending greater than that of the early start schedule is not possible. (This is so because in the early start schedule all activities start as early as possible.) Any release of funds above the early start schedule requirement curve is beyond the capacity of the project to spend.
3. The rate of spending corresponding to the late start schedule is the absolute minimum necessary to complete the project on time. If the rate of spending is less than that corresponding to the late start schedule the project duration will have to be necessarily extended.
4. A pattern of funds release lying between the two bounds, early start schedule requirement and late start schedule requirement, *prima facie* suggests that a schedule can be worked out without extending project duration.

Let us now look at the cumulative funds release pattern for our illustrative project. This lies between the early start schedule requirement and late start schedule requirement. So *prima facie* it suggests that a feasible schedule without extending the project duration can be developed. Let us proceed further and consider scheduling year by year. The activities that begin in year 1 according to the early start schedule are (1–2) and (1–3). If both these activities are commenced as early as possible, the fund requirement for year 1 would be Rs 8.4 million. Since this amount exceeds Rs 6.9 million, the amount to be released in year 1, the expenditure in year 1 has to be reduced by Rs 1.5 million. For this we consider the possibility of shifting activities to subsequent periods. Looking at activities (1–2) and (1–3) we find that (1–2) is on the critical path, so there is no flexibility available with respect to it. Activity (1–3), however, can be shifted as it is not on the critical path. Since activity (1–3) requires Rs 0.5 million per month it has to be shifted by three months so that the amount spent in year 1 is equal to the amount released in year 1. Since there is a free float of six months for activity (1–3), we shift it by three months.

We now go to year 2. The effects of shifting activity (1–3) by three months are as follows. (i) The funds requirement for year 2 on account of activity (1–3) increases by Rs 1.5 million over and above what it is for the early start schedule. (ii) The earliest starting time for activity (3–4) moves to 15 months from 12 months and the earliest finishing time moves to 23 months from 20 months. Since this shift occurs within year 2, there is no change in funds requirement on account of activity (3–4). (iii) The earliest starting time for activity (4–5) moves to 23 months from 20 months and the earliest finishing time for activity (4–5) moves to 25 months

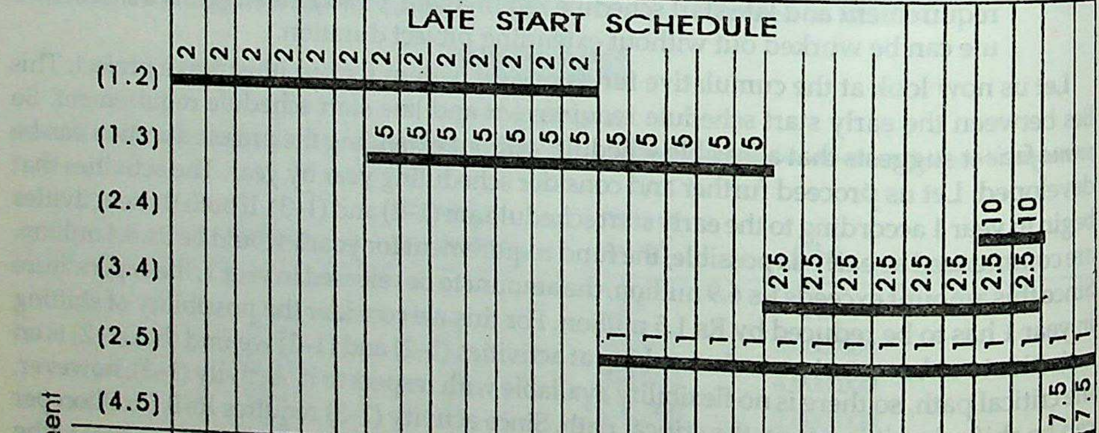
EXHIBIT 19.21



Project Requirement (Early Start Schedule)

Monthly	7	7	7	7	7	7	7	7	7	7	7	7	4.5	13.5	13.5	3.5	3.5	3.5	3.5	3.5	8.5	8.5	1	1	1	1	1	1
Cumulative	7	14	21	28	35	42	49	56	63	70	77	84	88.5	102	115.5	119	122.5	126	129.5	133	141.5	150	151	152	153	154	155	156

Month 0 5 10 15 20 25 28

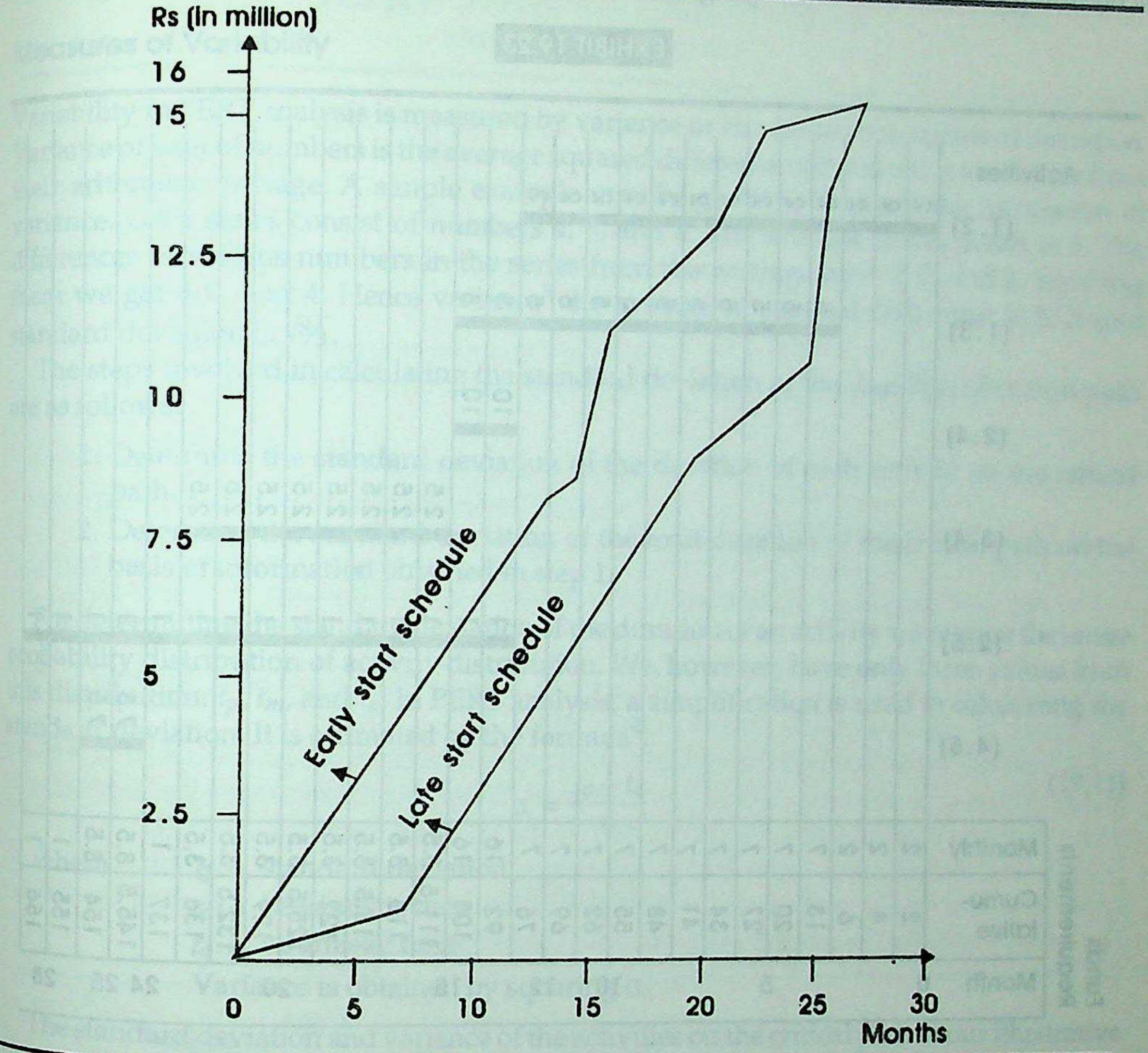


Project Requirement (Late Start Schedule)

Monthly	2	2	2	2	2	2	7	7	7	7	7	7	7	6	6	6	6	6	3.5	3.5	3.5	3.5	3.5	3.5	13.5	13.5	8.5	8.5
Cumulative	2	4	6	8	10	12	19	26	33	40	47	54	61	67	73	79	85	91	94.5	98.0	101.5	105	108.5	112	125.5	139	147.5	156

from 23 months. This decreases the funds requirement for year 2 by Rs 0.75 million. The net effect, therefore, is to increase funds requirement by Rs 0. 75 million over and above what it is for the earliest starting schedule. Hence the total requirement becomes Rs 6.8 million + Rs 0.75 million = Rs 7.55 million. However, the funds budgeted for year 2 are only Rs 6.8 million. So we consider the possibility of shifting some activities to year 3. We find that by

EXHIBIT 19.22



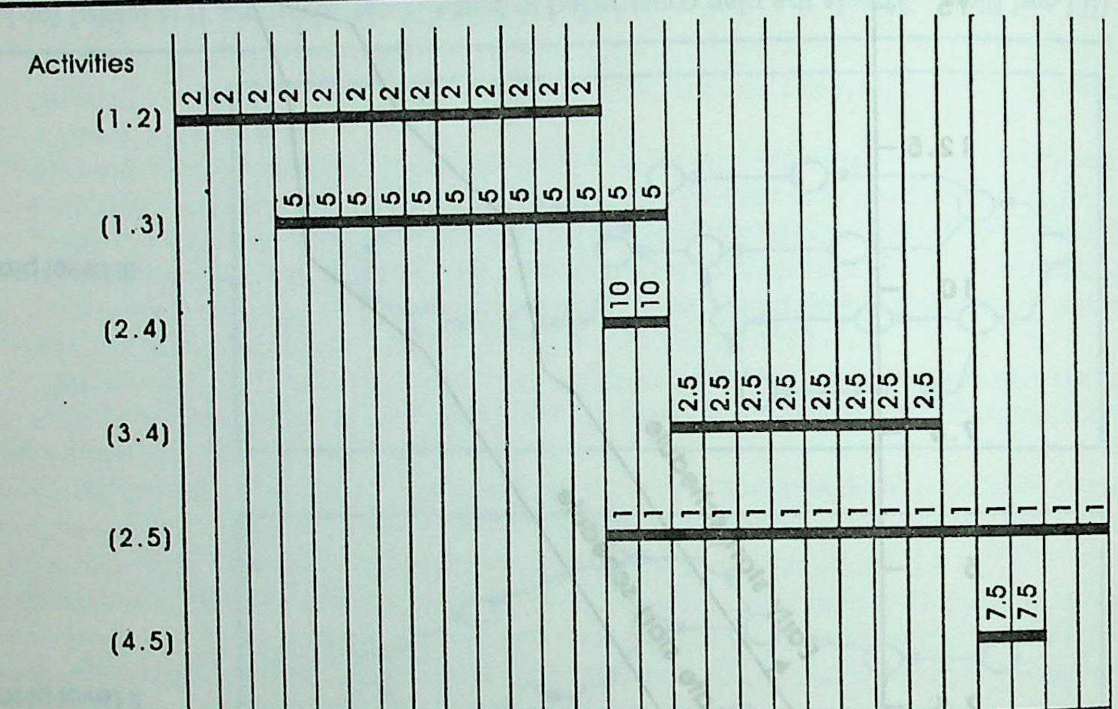
shifting activity (4–5) to year 3 the expenditure in year 2 can be reduced to Rs 6.8 million, the budget of that year. As a result of this shifting the expenditure for year 3 (first four months of it) equals the budgeted funds release for year 3. The schedule arrived at finally is shown in Exhibit 19.23.

Problems in Scheduling Real Life Projects

In the above discussion we have considered simple examples comprising few activities and one constraint, to indicate the broad approach. In real life projects the activities run into hundreds and there may be several constraints. The problem of scheduling in such cases tends to become very complex. For solving such problems the technique of linear programming can be used. However, when a problem has numerous activities, say, more than 100, the technique of linear programming becomes computationally unwieldy and inordinately expensive, even with the aid of the fastest computers available.

In view of the practical difficulties in using linear programming for solving large-scale scheduling problems, heuristic programs have been developed.

EXHIBIT 19.23



Funds Requirements																												
Monthly	2	2	2	7	7	7	7	7	7	7	7	7	7	16	16	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	1	8.5	8.5	1	1
Cumulative	2	4	6	13	20	27	34	41	48	55	62	69	76	92	108	111.5	115	118.5	122	125.5	129	132.5	136	137	145.5	154	155	156

Month 0 5 10 12 15 20 24 25 28

A heuristic is a rule of thumb like 'schedule critical activities first' or 'schedule the activity which has the largest independent float in the end'. A heuristic program consists of a collection of such heuristics. In recent years many heuristic programs have been developed —they are formulated usually as computer programs. These programs may be broadly divided into two types: resource levelling programs and resource allocation programs. A resource levelling program seeks level resource requirements, given a constraint on project duration. A resource allocation program tries to find the shortest project schedule, given fixed resource availabilities.

PERT MODEL

So far the analysis was focused on the determination of the critical path, event slacks, and activity floats. For this purpose we used single time estimates of activity duration though initially three-time estimates were developed for each activity. Now we consider the variability of project duration.

Measures of Variability

Variability in PERT analysis is measured by variance or its square root, standard deviation. Variance of a set of numbers is the average squared difference of the numbers in the set from their arithmetic average. A simple example may be given to illustrate the calculation of variance. Let a series consist of numbers 4, 6, and 8. The average of this series is 6. The differences of various numbers in the series from this average are—2, 0, and 2. Squaring them we get 4, 0, and 4. Hence variance[1] the average of squared difference is 8/3, and standard deviation is $\sqrt{8/3}$.

The steps involved in calculating the standard deviation of the duration of critical path are as follows:

1. Determine the standard deviation of the duration of each activity on the critical path.
2. Determine the standard deviation of the total duration of the critical path on the basis of information obtained in step 1.

For determining the standard deviation of the duration of an activity we require the entire probability distribution of activity distribution. We, however, have only three values from this distribution: t_p, t_m, and t_o. In PERT analysis, a simplification is used in calculating the standard deviation. It is estimated by the formula[2].

$$\sigma = \frac{t_p - t_o}{6} \tag{19.11}$$

where σ = standard deviation
t_p = pessimistic time
t_o = optimistic time
Variance is obtained by squaring σ.

The standard deviation and variance of the activities on the critical path of our illustrative project are shown in Exhibit 19.24.

Assuming that the probability distribution of various activities on the critical path are independent, the variance of the critical path duration is obtained by adding variances of

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[1] In this example we assumed that the three values 4, 6, and 8 had the same probability of occurrence (1/3) and hence we did not consider probabilities explicitly. Where the values have different probabilities associated with them, probabilities are considered explicitly. Variance is calculated by the formula $\sum p_i (X_i - \overline{X})^2$. X_i is a possible value, p_i is the probability associated with it, and $\overline{X}$ is the weighted arithmetic average of X'_is. This means $\overline{X} = \sum p_i X_i$.

[2] In this formula σ is one-sixth of the difference between the two extreme time estimaties, t_p and t_o. It is based on the fact that nearly all the distribution of a single-peaked distribution falls within three standard deviations of the mean. For a normal distribution, more than 99.5 per cent of the distribution lies within this interval and for no single-peaked distribution is it less than 89 per cent according to Tchebycheff's inequality. This means that t_o and t_p are not necessarily the end points of the range of possible values but points beyond which the probability of occurrence is very small.

EXHIBIT 19.24

Standard Deviation and Variance of Activity Duration on Critical Path

Activity	t_p	t_o	$\sigma = t_p - t_o/6$	Variance = σ^2
(1–2)	21	9	2	4.00
(2–5)	24	10	2.33	5.44

activities on the critical path[3].

Variance (critical path duration) = Sum of variances of activity durations on the critical path

This means

$$\text{Standard deviation (critical path duration)} = \left(\begin{array}{l}\text{Sum of variances of}\\ \text{activity durations on}\\ \text{the critical path}\end{array}\right)^{1/2}$$

The standard deviation of the critical path duration for our illustrative project is

$$(4 + 5.44)^{1/2} = 3.07$$

Now we know that the mean[4] and standard deviation of the critical path duration for our project are 28 weeks and 3.07 weeks, respectively.

For real life projects which have a large number of activities on the critical path we can reasonably assume that the critical path duration is approximately normally distributed[5] with mean and standard deviation obtained by the method described above.

A normal distribution looks like a bell-shaped curve as shown in Exhibit 19.25. It is symmetric and single peaked and is fully described by its mean and standard deviation. The probability of values lying within certain ranges is as follows:

Range	Probability
Mean ± One standard deviation	0.682
Mean ± Two standard deviations	0.954
Mean ± Three standard deviations	0.998

---

[3] This is based on an elementary theorem in statistics which says that when $X_1, X_2, X_3, \ldots X_n$ are independent variables the following holds true:

$$\begin{aligned}\text{Variance}\,(X_1 + X_2 \ldots + X_n) = {} & \text{Variance}\,(X_1)\\ & + \text{Variance}\,(X_2)\\ & \;\vdots\\ & + \text{Variance}\,(X_n)\end{aligned}$$

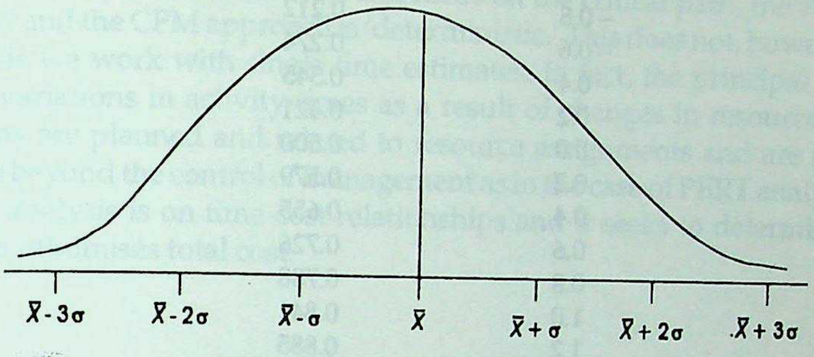
[4] The mean length of the critical path is simply the sum of the mean values of activity durations on the critical path. This is based on an elementary theorem in statistics which says

$$E\,(X_1 + X_2 \ldots + X_n) = E\,(X_1) + E\,(X_2) \ldots E(X_n)$$

E stands for expected value or the mean value.

[5] This assumption is based on the central limit theorem, a fundamental theorem in statistics, which says that the sum of a large number of independent random variables is approximately normally distributed, irrespective of how the individual random variables are distributed.

EXHIBIT 19.25



Probability of Completion by a Specified Date

Armed with information about mean (T) and standard deviation (σ) for critical path duration, which is normally distributed, we can compute the probability of completion by a specified date (D) as follows:

1. Find $Z = \dfrac{D - T}{\sigma}$
2. Obtain cumulative probability up to Z[6] by looking at the probability distribution of the standard normal variate.

This is shown in Exhibit 19.26.

EXHIBIT 19.26

Cumulative Probability up to Z for Standard Normal Distribution

Z	Cumulative probability
− 3.0	0.001
− 2.8	0.003
− 2.6	0.005
− 2.4	0.008
− 2.2	0.014
− 2.0	0.023
− 1.8	0.036
− 1.6	0.055
− 1.4	0.081

(Continued)

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[6] Z represents the number of standard deviations by which D, the specified date, exceeds T, the mean critical path duration. Determining Z is equivalent to converting our specific normal distribution (with mean T and standard deviation σ) into standard normal distribution. The mean and standard deviation of standard normal distribution are 0 and 1 respectively.

Exhibit 19.26 (continued)

Z	Cumulative probability
−1.2	0.115
−1.0	0.159
−0.8	0.212
−0.6	0.274
−0.4	0.345
−0.2	0.421
0.0	0.500
0.2	0.579
0.4	0.655
0.6	0.726
0.8	0.788
1.0	0.841
1.2	0.885
1.4	0.919
1.6	0.945
1.8	0.964
2.0	0.977
2.2	0.986
2.4	0.992
2.6	0.995
2.8	0.997
3.0	0.999

The above procedure may be illustrated for our project[7] which has $T=28$ and $\sigma=3.07$. The probability of completing this project by certain specified dates is shown in Exhibit 19.27.

EXHIBIT 19.27

Probability of Completion by the Specified Date

Specified date (D)	Z	Probability of completion by D
20	$\frac{20-28}{3.07} \cong -2.6$	0.005
25	$\frac{25-28}{3.07} \cong -1.0$	0.159
30	$\frac{30-28}{3.07} \cong 0.6$	0.726

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[7] It may be noted that in our illustrative project there are only two activities on the critical path and hence the assumption that the project duration is approximately normally distributed may not be realistic. However, as real life projects have a large number of activities on their critical paths, the procedure illustrated here is useful for them.

CPM MODEL

The PERT model was developed for projects characterised by uncertainty and the CPM model was developed for projects which are relatively risk-free. While both the approaches begin with the development of network and focus on the critical path, the PERT approach is 'probabilistic' and the CPM approach is 'deterministic.' This does not, however, mean that in CPM analysis we work with single time estimates. In fact, the principal focus of CPM analysis is on variations in activity times as a result of changes in resource assignments. These variations are planned and related to resource assignments and are not caused by random factors beyond the control of management as in the case of PERT analysis. The main thrust of CPM analysis is on time-cost relationships and it seeks to determine the project schedule which minimises total cost.

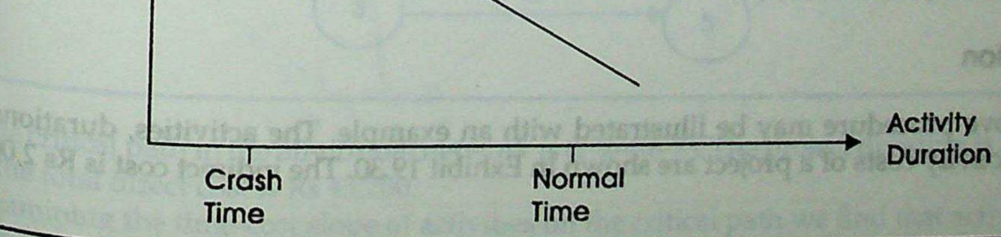
Assumptions

The usual assumptions underlying CPM analysis are:

1. The costs associated with a project can be divided into two components: direct costs and indirect costs. Direct costs are incurred on direct material and direct labour. Indirect costs consist of overhead items like indirect supplies, rent, insurance, managerial services, etc.
2. Activities of the project can be expedited by crashing which involves employing more resources.
3. Crashing reduces time but enhances direct costs because of factors like overtime payments, extra payments, and wastage. The relationship between time and direct activity cost can be reasonably approximated by a downward sloping straight line.

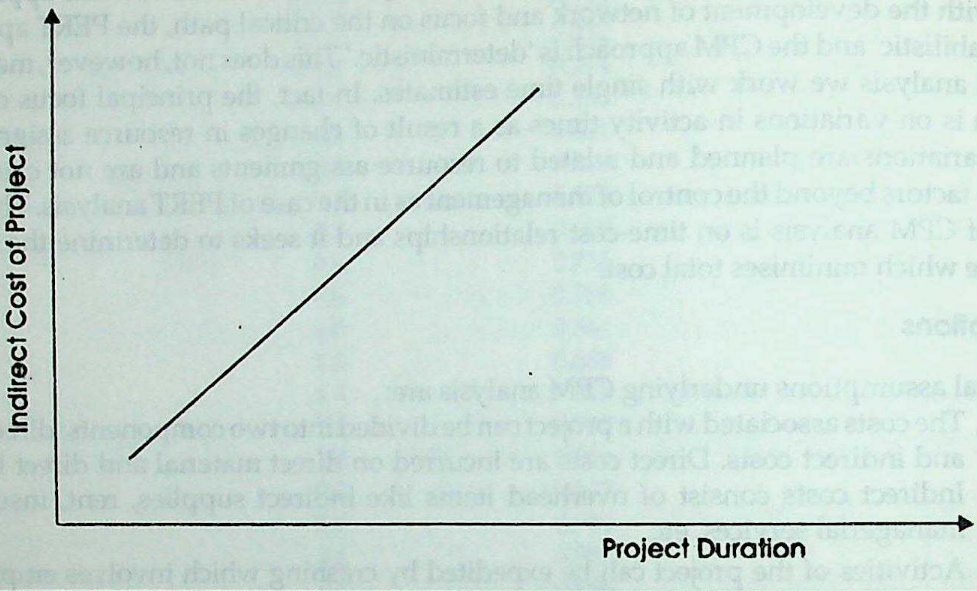
A typical cost-time line is shown in Exhibit 19.28.

EXHIBIT 19.28



4. Indirect costs associated with the project increase linearly with project duration. A typical line for indirect costs is shown in Exhibit 19.29.

EXHIBIT 19.29



Procedure

Given the above assumptions, CPM analysis seeks to examine the consequences of crashing on total cost (direct cost plus indirect cost). Since the behaviour of indirect project cost is well defined, the bulk of CPM analysis is concerned with the relationship between total direct cost and project duration. The procedure used in this respect is generally as follows:

1. Obtain the critical path in the normal network. Determine the project duration and direct cost.
2. Examine the cost-time slope of activities on the critical path obtained and crash the activity which has the least slope.[8]
3. Construct the new critical path after crashing as per step 2. Determine project duration and cost.
4. Repeat steps 2 and 3 till activities on the critical path (which may change every time) are crashed.

Illustration

The above procedure may be illustrated with an example. The activities, durations, and direct activity costs of a project are shown in Exhibit 19.30. The indirect cost is Rs 2,000 per week.

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[8] If there is more than one critical path, one activity on each of the critical paths should be crashed. The activity crashed on each critical path, of course, will have the lowest cost-time slope on that path.

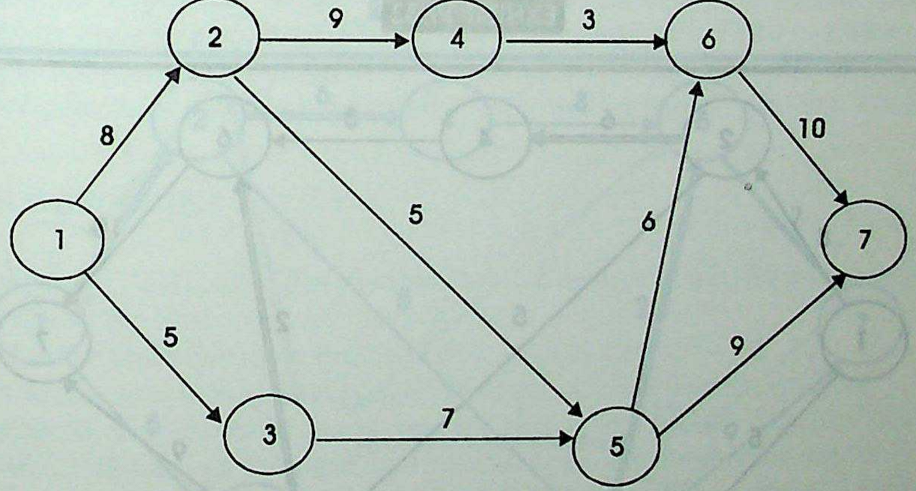
EXHIBIT 19.30

Normal and Crash Time and Cost

Activity	*Time in Weeks* Normal	Crash	Cost Normal	Crash	Cost to expedite per week
			Rs	Rs	Rs
1 – 2	8	4	3,000	6,000	750
1 – 3	5	3	4,000	8,000	2,000
2 – 4	9	6	4,000	5,500	500
3 – 5	7	5	2,000	3,200	600
2 – 5	5	1	8,000	12,000	1,000
4 – 6	3	2½	10,000	11,200	2,400
5 – 6	6	2	4,000	6,800	700
6 – 7	10	7	6,000	8,700	900
5 – 7	9	5	4,200	9,000	1,200
			45,200	70,400	

The project network with normal duration is shown in Exhibit 19.31.

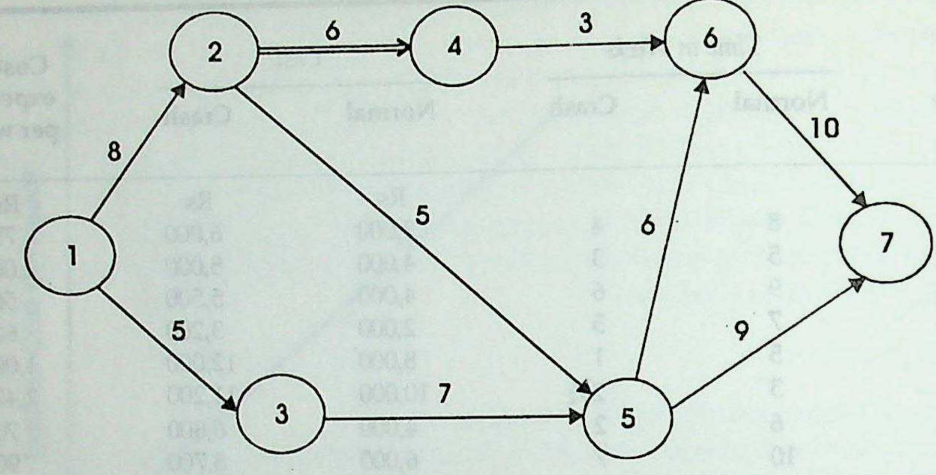
EXHIBIT 19.31



The critical path in the all-normal network is (1-2-4-6-7). The project duration is 30 weeks and the total direct cost is Rs 45,200.

Examining the time-cost slope of activities on the critical path we find that activity (2-4) has the lowest slope; in other words, the cost to expedite per week is the lowest for activity (2-4). Hence activity (2-4) is crashed. The project network after such crashing is shown in Exhibit 19.32.

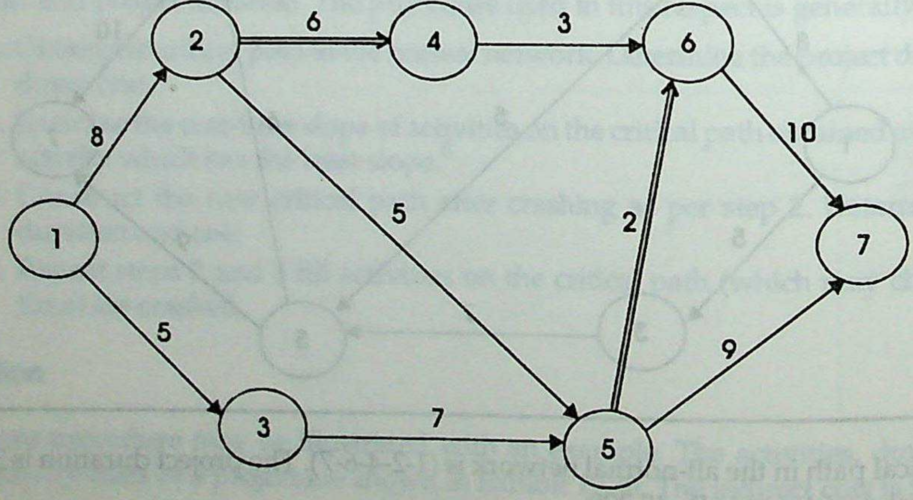
EXHIBIT 19.32



As per Exhibit 19.32 the critical path is (1-2-5-6-7), with a length of 29 weeks, and the total direct cost is Rs 46,700.

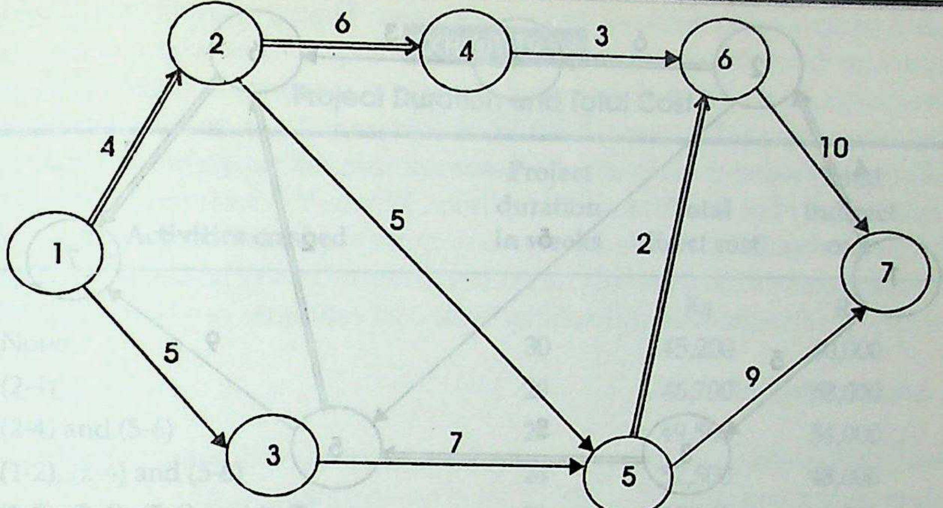
Looking at the time-cost slope of the activities on the new critical path (1-2-5-6-7), we find that the activity (5-6) has the lowest slope. Hence this activity is crashed. The project network after such crashing is shown in Exhibit 19.33. As per this figure the critical path is (1-2-4-6-7) with a length of 27 weeks and the total direct cost is Rs 49,500.

EXHIBIT 19.33



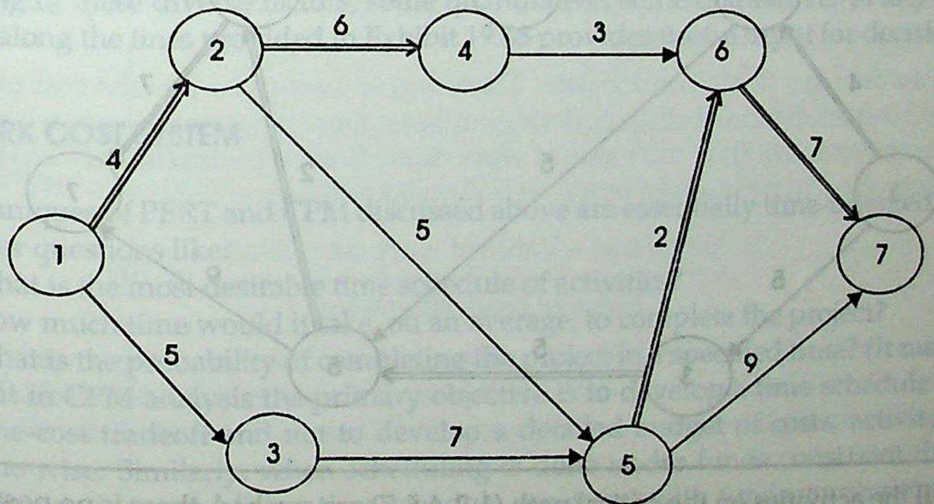
Comparing the time cost-slope of the non-crashed activities on the new critical path (1-2-4-6-7) we find that the activity which costs least to crash is (1-2). Hence this is crashed. The project network after such crashing is shown in Exhibit 19.34. As per this figure the critical path is (1-3-5-6-7) with a length of 24 weeks and the total direct cost is Rs 52,500.

EXHIBIT 19.34



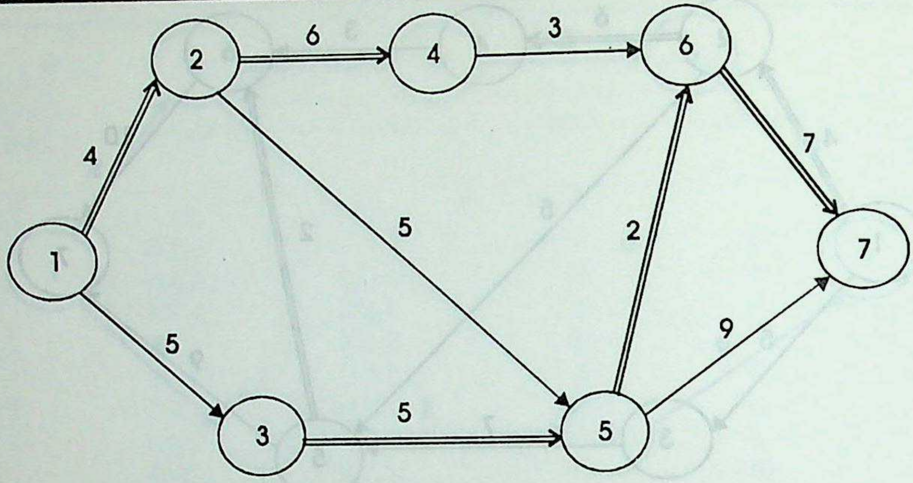
Looking at the time-cost slope of the non-crashed activities on the new critical path (1-3-5-6-7), we find that activity (6-7) has the lowest slope. Hence it is crashed. The project network after such crashing is shown in Exhibit 19.35. As per this figure there are two critical paths (1-3-5-6-7) and (1-3-5-7), both with a length of 21 weeks, and the total direct cost is Rs 55,200.

EXHIBIT 19.35



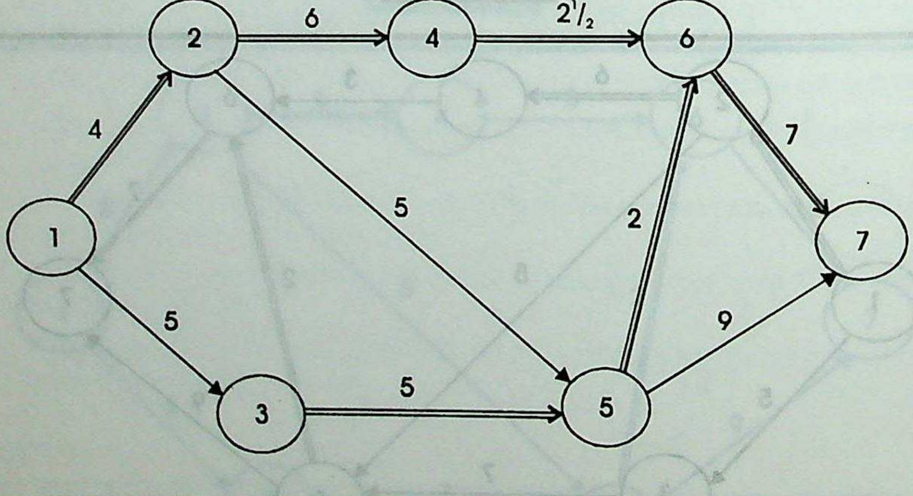
Considering the time-cost slope of non-crashed activities on critical paths (1-3-5-6-7) and (1-3-5-7) we find that activity (3-5) which is common to both the critical paths is the least costly to crash. Hence, it is crashed. The project network after this crashing is shown in Exhibit 19.36. As per this figure, the critical path is (1-2-4-6-7) with a duration of 20 weeks and the total direct cost is Rs 56,400.

EXHIBIT 19.36



Looking at the new critical path (1-2-4-6-7) we find that the only crashed activity is (4-6). Crashing this gives us the project network shown in Exhibit 19.37. As per this figure, the critical path again is (1-2-4-6-7) with a duration of 19½ weeks and the total direct cost is Rs 57,600.

EXHIBIT 19.37



Since all the activities on the critical path (1-2-4-6-7) are crashed, there is no possibility of further time reduction. Hence let us now look at the time-cost relationship. Exhibit 19.38 shows this[9].

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[9] At this stage, we look at the crashed activities on the non-critical paths to find out whether they can be de-crashed without increasing the project duration as indicated by the critical path (1-2-4-6-7). If this is possible, we begin with the activity which has the highest time-cost slope and proceed in the order of the decreasing time-cost slope. In our project, however, there is no scope for de-crashing on the non-critical path because it is not possible to do so without increasing the project duration.

From Exhibit 19.38, we find that the total cost is minimised for the project schedule represented by Exhibit 19.37 in which the activities crashed are (1-2), (2-4), (3-5), (5-6), and (6-7). The information provided in Exhibit 19.38 is useful for decision making.

EXHIBIT 19.38

Project Duration and Total Cost

Exhibit	Activities crashed	Project duration in weeks	Total direct cost	Total indirect cost	Total cost
			Rs	Rs	Rs
19.31	None	30	45,200	60,000	105,200
19.32	(2-4)	29	46,700	58,000	104,700
19.33	(2-4) and (5-6)	27	49,500	54,000	103,500
19.34	(1-2), (2-4) and (5-6)	24	52,500	48,000	100,500
19.35	(1-2), (2-4), (5-6) and (6-7)	21	55,200	42,000	97,200
19.36	(1-2), (2-4), (3-5), (5-6) and (6-7)	20	56,400	40,000	96,400
19.37	(1-2), (2-4), (3-5) (5-6), (4-6) and (6-7)	19½	57,600	39,000	96,600

If the objective is to minimise the total cost of the project, the pattern of crashing suggested by Exhibit 19.36 is optimal. If the objective is to minimise the project duration then the pattern of crashing suggested by Exhibit 19.37 is optimal. In real life situations, however, both the factors may be important. In addition, factors like strain on resources and degree of manageability are also important. The final decision would involve a careful weighing and balancing of these diverse factors, some quantitative, some qualitative. In any case, information along the lines provided in Exhibit 19.38 provides useful input for decision making.

NETWORK COST SYSTEM

The techniques of PERT and CPM discussed above are essentially time-oriented. They seek to answer questions like:

- What is the most desirable time schedule of activities?
- How much time would it take, on an average, to complete the project?
- What is the probability of completing the project in a specified time? (It may be noted that in CPM analysis the primary objective is to develop a time schedule in view of time-cost tradeoff and not to develop a detailed budget of costs, activity-wise and time-wise. Similarly, when scheduling is done under funds constraint the primary objective is to establish a time schedule consistent with funds constraint and not to develop a system for cost planning and control.)

Such analysis largely overlooks the cost aspect which is usually as important as the time aspect and sometimes even more. To provide a vehicle for cost planning and control of projects, the network cost system was developed. This represents a very useful supplement to the traditional time-oriented network analysis. Let us look at the cost projection and cost analysis and control under network cost system.

Cost Projection

The basic principle of network cost system is fairly simple: costs are planned, measured, analysed, and controlled in terms of project activities. Though simple, this principle represents a departure from the conventional cost accounting system where costs are generally planned, measured, analysed, and controlled in terms of functions or organisational divisions.

Once costs are estimated in terms of activities, cost projections can be made for any chosen schedule. For cost projection it is usually assumed that the expenditure for any activity is incurred evenly over the duration of the activity. Where this assumption does not appear valid, the activity should be divided into two or more sequential components, such that for each of the components the expenditure occurs uniformly over its duration. The projected cost curve for a given schedule and activity-wise cost estimates can be readily obtained.

Analysis and Control of Costs

As the project progresses the following may be measured/estimated periodically for purposes of monitoring and control.

1. *Costs incurred to date* In a network cost system costs are recorded activity-wise. Costs incurred to date can be obtained by summing up costs for various activities.
2. *Budgeted costs to date* Budgeted costs to date can be readily obtained from the cost projections made at the beginning.
3. *Value of work done to date* When costs are measured, an estimate should also be made of the extent of work accomplished. The value of work done can then be obtained as follows: budgeted costs × percentage work accomplished. This may be illustrated by an example. A certain activity has a budgeted cost of Rs 80,000 and at the time of the periodic progress review it is estimated that 60 per cent of the work has been accomplished. So the value of work done is put at Rs 80,000 × 60 per cent = Rs 48,000.
4. *Cost over-run (under-run) to date* There is cost over-run when the cost incurred is more than the value of work done. Similarly, there is cost under-run when the cost incurred is less than the value of work done. Cost over-run (under-run) is usually expressed in percentage terms. It is defined as follows:

$$\frac{\text{Actual cost} - \text{Value of work completed}}{\text{Value of work completed}} \times 100$$

5. *Time over-run (under-run) to date* There is time over-run if the project is behind schedule. Likewise, there is time under-run if the project is ahead of schedule. Time over-run (under-run) is usually defined in terms of months behind or months ahead.

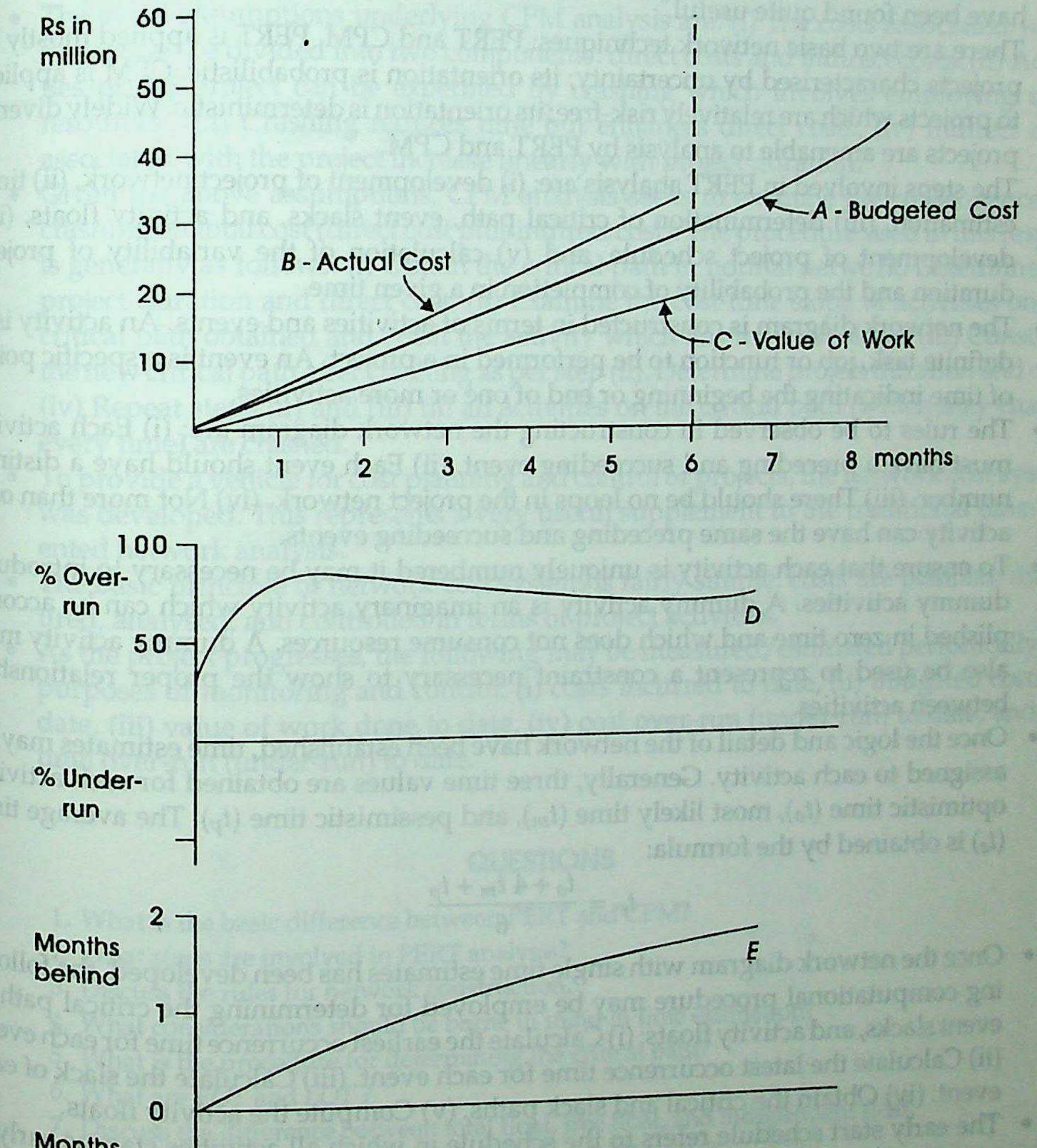
Graphic Display

The above information may be displayed graphically as shown in Exhibit 19.39.

Exhibit 19.39 has three graphs. The first graph shows budgeted costs (curve A), actual costs (curve B), and value of work (curve C). The second graph shows percentage cost over-run or under-run (curve D). It may be noted that curve D is derived from curves B and

C. The vertical distance between curves B and C is divided by the height of curve C and multiplied by 100 to get curve D. The third graph shows the number of months by which the project is behind or ahead of the schedule (curve E). Curve E is derived from curves A and C. The months behind/ahead at any particular point of time is simply the horizontal

EXHIBIT 19.39



distance (measured in months) of curve C at that point of time and curve A. Exhibit 19.39 provides information about time and cost, budgeted and actual, at one place and is a very useful device for monitoring and control.

SUMMARY

- For proper planning, scheduling, and control of the activities of a project, given their interrelationships and constraints on the availability of resources, network techniques have been found quite useful.
- There are two basic network techniques: PERT and CPM. PERT is applied mostly to projects characterised by uncertainty; its orientation is probabilistic. CPM is applied to projects which are relatively risk-free; its orientation is deterministic. Widely diverse projects are amenable to analysis by PERT and CPM.
- The steps involved in PERT analysis are: (i) development of project network, (ii) time estimation, (iii) determination of critical path, event slacks, and activity floats, (iv) development of project schedule, and (v) calculation of the variability of project duration and the probability of completion in a given time.
- The network diagram is constructed in terms of activities and events. An activity is a definite task, job or function to be performed in a project. An event is a specific point of time indicating the beginning or end of one or more activities.
- The rules to be observed in constructing the network diagram are: (i) Each activity must have a preceding and succeeding event. (ii) Each event should have a distinct number. (iii) There should be no loops in the project network. (iv) Not more than one activity can have the same preceding and succeeding events.
- To ensure that each activity is uniquely numbered it may be necessary to introduce dummy activities. A dummy activity is an imaginary activity which can be accomplished in zero time and which does not consume resources. A dummy activity may also be used to represent a constraint necessary to show the proper relationship between activities.
- Once the logic and detail of the network have been established, time estimates may be assigned to each activity. Generally, three time values are obtained for each activity: optimistic time (t_o), most likely time (t_m), and pessimistic time (t_p). The average time (t_e) is obtained by the formula:

$$t_e = \frac{t_o + 4\,t_m + t_p}{6}$$

- Once the network diagram with single time estimates has been developed, the following computational procedure may be employed for determining the critical path/s, event slacks, and activity floats: (i) Calculate the earliest occurrence time for each event. (ii) Calculate the latest occurrence time for each event. (iii) Calculate the slack of each event. (iv) Obtain the critical and slack paths. (v) Compute the activity floats.
- The early start schedule refers to the schedule in which all activities start as early as possible. The late start schedule reflects a desire to commit resources late—as late as possible.
- In real life situations there may be restrictions on the availability of resources. In the face of these, various schedules may have to be considered to find out which one is

most appropriate in the light of these restrictions.

- Variability in PERT analysis is measured by variance or its square root, standard deviation.
- The steps involved in calculating the standard deviation of the duration of critical path are as follows: (i) Determine the standard deviation of the duration of each activity on the critical path. (ii) Determine the standard deviation of the total duration of the critical path on the basis of information obtained in step (i).
- Armed with information about the mean and standard deviation of critical path duration, we can compute the probability of completion by a specified date.
- The usual assumptions underlying CPM analysis are: (i) The costs associated with a project can be divided into two components: direct costs and indirect costs. (ii) Activities of the project can be expedited by crashing which involves employing more resources. (iii) Crashing reduces time but enhances direct costs. (iv) Indirect costs associated with the project increase linearly with project duration.
- Given the above assumptions, CPM analysis seeks to examine the consequences of crashing on total cost (direct cost plus indirect cost). The procedure used in this respect is generally as follows: (i) Obtain the critical path in normal network. Determine the project duration and direct cost. (ii) Examine the cost-time slope of activities on the critical path obtained and crash the activity which has the least slope. (iii) Construct the new critical path after crashing as per step (ii). Determine project duration and cost. (iv) Repeat steps (ii) and (iii) till all activities on the critical path (which may change every time) are crashed.
- To provide a vehicle for cost planning and control of projects, the network cost system was developed. This represents a very useful supplement to the traditional time-oriented network analysis.
- The basic principle of network cost system is fairly simple: costs are planned, measured, analysed, and controlled in terms of project activities.
- As the project progresses, the following may be measured/estimated periodically for purposes of monitoring and control: (i) costs incurred to date, (ii) budgeted costs to date, (iii) value of work done to date, (iv) cost over-run (under-run) to date, and (v) time over-run (under-run) to date.

QUESTIONS

1. What is the basic difference between PERT and CPM?
2. What steps are involved in PERT analysis?
3. Discuss the rules for network construction.
4. What considerations should be borne in mind in time estimation?
5. What is the procedure for determining the critical path?
6. What are *EOT* and *LOT* ?
7. Discuss the difference between total float, free float, and independent float.
8. What is an early start schedule and a late start schedule?
9. Illustrate the problem of scheduling in view of resource constraints with the help of an example.
10. How would you calculate the variability of project duration and probability of completion at a specified time? Illustrate with an example.

11. What are the usual assumptions underlying CPM analysis?
12. Discuss the procedure of CPM analysis with the help of a simple example.
13. Discuss the basic principle of network cost system.
14. What kind of periodic monitoring is done in a network cost system?

PROBLEMS

1. Draw the network diagram for an industrial project with which you are familiar.
2. A project consists of the following activities represented in terms of preceding and succeeding events.

Activity	Mean time (weeks)
(1, 2)	4
(1, 3)	2
(1, 4)	3
(2, 4)	5
(3, 4)	6
(4, 5)	2
(5, 7)	3
(2, 5)	1
(4, 7)	5

3. A project consists of 12 activities and their time estimates are shown below:

Activity	Time (in weeks)		
	t_o	t_m	t_p
(1 – 2)	4	6	10
(1 – 3)	3	7	12
(1 – 4)	5	6	9
(1 – 7)	2	4	6
(2 – 4)	6	10	20
(2 – 6)	3	4	7
(2 – 7)	5	9	15
(3 – 4)	3	7	12
(4 – 5)	2	4	5
(5 – 6)	1	3	6
(3 – 7)	2	5	8
(6 – 7)	1	2	6

(a) Draw the network diagram.
(b) Determine the critical path.

(c) Calculate event slacks and activity floats.

(d) Find the standard deviation of the critical path duration.

(e) Compute the probability of completing the project in 30 weeks.

4. The normal and crash times and direct costs for the activities of a project are shown below:

Activity	**Time**		**Cost**	
	Normal	*Crash*	*Normal*	*Crash*
(1 – 2)	5	2	6000	9000
(2 – 4)	6	3	7000	10000
(1 – 3)	4	2	1000	2000
(3 – 4)	7	4	4000	8000
(4 – 7)	9	5	6000	9200
(3 – 5)	12	3	16000	19600
(4 – 6)	10	6	15000	18000
(6 – 7)	7	4	4000	4900
(7 – 9)	6	4	3000	4200
(5 – 9)	12	7	4000	8500

(a) Draw the network diagram.

(b) Determine all normal and critical path.

(c) Find the minimum cost project schedule if the indirect costs are Rs 1000 per week.

PART 6

REVIEW

Project Review and Administrative Aspects

20

Project Review and Administrative Aspects

Project review, as discussed earlier, represents the final phase of capital budgeting. It is concerned with questions like: Are the costs of the project within reasonable limits? Should the project be continued or abandoned?

This chapter examines various facets of project review. It also discusses administrative aspects of capital budgeting. It is organised as follows:

- Initial review
- Performance evaluation
- Abandonment analysis
- Behavioural issues in project abandonment
- Administrative aspects of capital budgeting
- Evaluating the capital budgeting system of an organisation.

INITIAL REVIEW

The initial review of a project is of two types:

- Control of project in progress
- Postaudit

Control of Project in Progress

The expenditure authorisation for a project generally specifies how much can be spent by whom and when. To ensure that the actual expenditure does not deviate significantly from the authorised expenditure, periodical control is exercised during project implementation.

Problem of Over-run An important aspect of control relates to over-runs. Since capital outlays are affected by numerous uncertainties, the actual outlay usually differs from the expected outlay, and in most of the cases it exceeds the expected outlay. In this context, a question arises: How much over-run can be allowed without review? A natural answer would be that marginal over-runs may be permitted without review but significant over-runs should be allowed only after review. This policy is followed by many companies. In one company, for example, over-runs exceeding 10 per cent call for review. The specific percentages applicable to different kinds of projects will have to be worked out by each firm in the light of its special characteristics.

Postaudit

An audit of a project after it has been commissioned is referred to as postaudit or post completion audit. Most firms do a postaudit for almost every project above some threshold limit. Such an audit compares actual performance vis-a-vis planned performance when the operations of the project stabilise.

Why should postaudit be done? When should postaudit be done? Who should do the postaudit?

☐ *Why* Postaudit is a useful tool of capital budgeting. As Haim Levy and Marshall Sarnat[1] said:

> Although past mistakes cannot be undone, a careful analysis of the deviations of actual from planned performance may help to prevent history from repeating itself. If investment outlays are consistently underestimated by 5-10%, a rule of thumb correction of that order of magnitude may be called for.

Regular postaudits of capital projects

(i) provide a documented log of experience that may be valuable in improving future decision making,
(ii) enable the firm in identifying individuals with superior abilities in planning and forecasting,
(iii) help in discovering systematic biases in judgement,
(iv) induce healthy caution among project sponsors, and
(v) serve as a useful training ground for promising executives who need broader business experience and exposure.

☐ *When* Postaudit may be done when the project is just commissioned or when the operations of the project stabilise or when the project is terminated or at some other time in the life of the project. Since the primary purpose of postaudit is to draw lessons from experience and improve future decisions, the most appropriate time seems to be when the project operations stabilise. If it is conducted earlier, the review data may not be very meaningful and if it is conducted towards the end of project life the utility of the lessons drawn is likely to diminish.

☐ *Who* Postaudit may be performed by an independent group consisting of executives drawn from different backgrounds (engineering, accountancy, marketing, planning, and so on). As postaudit provides valuable experience, the members of the postaudit team typically should consist of individuals who are being groomed to shoulder higher responsibilities. Postaudit work should not be entrusted to the sponsoring group because it has a natural bias in favour of the project.

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[1] Haim Levy and Marshall Sarnat, *Capital Investment and Financing Decisions*, 2nd ed., Englewood Cliffs, N.J: Prentice-Hall, 1983, p. 23.

PERFORMANCE EVALUATION

While the postaudit is typically a one-time exercise, performance evaluation is done periodically. It seeks to measure the performance of the project on an ongoing basis.

Performance evaluation may be done in terms of economic rate of return or book return on investment.

$$\text{Economic rate of return for a given year} = \frac{\text{Cash flow} + \text{Changes in present value}}{\text{Present value at the beginning of the year}}$$

$$\text{Book return on investment for a given year} = \frac{\text{Cash flow} + \text{Changes in book value}}{\text{Book value at the beginning of the year}}$$

The calculation of these measures may be illustrated with an example. Modern Enterprises Limited is considering an investment of Rs 100 million in a new electronics unit which has an economic life of 7 years. The projected cash flows are as follows:

Year	1	2	3	4	5	6	7
Cash flow (Rs in million)	14	16	17	29	29	29	29

If the opportunity cost of capital is 12 per cent, the *NPV* of the project turns out to be zero.

$$NPV = -100 + \frac{14}{(1.12)} + \frac{16}{(1.12)^2} + \frac{17}{(1.12)^3} + \frac{29}{(1.12)^4}$$

$$+ \frac{29}{(1.12)^5} + \frac{29}{(1.12)^6} + \frac{29}{(1.12)^7} = 0$$

The economic rate of return and the book return on investment (assuming a straight line depreciation over the 7-year life) for the electronics project are shown in Exhibits 20.1 and 20.2 respectively.

EXHIBIT 20.1

Calculation of Economic Rate of Return

(Rs in million)

Year	1	2	3	4	5	6	7
Cash flow	14	16	17	29	29	29	29
Present value at the beginning of the year, 12 per cent discount rate	100	98	93.8	88.1	69.7	49.0	25.9
Present value at the end of the year, 12 per cent discount rate	98	93.8	88.1	69.7	49.0	25.9	0
Change in value during the year	– 2	– 4.2	– 5.7	– 18.4	– 20.7	– 23.1	– 25.9
Economic income	12	11.8	11.3	10.6	8.3	5.9	3.1
Rate of return	.12	.12	.12	.12	.12	.12	.12
Economic depreciation	2	4.2	5.7	18.4	20.7	23.1	25.9

EXHIBIT 20.2

Calculation of Book Return on Investment

(Rs in million)

Year	1	2	3	4	5	6	7
Cash flow	14	16	17	29	29	29	29
Book value at the beginning of the year, straight line depreciation	100	85.7	71.4	57.1	42.9	28.6	14.3
Book value at the end of the year, straight line depreciation	85.7	71.4	57.1	42.9	28.6	14.3	0
Change in book value during the year	– 14.3	– 14.3	– 14.3	– 14.3	– 14.3	– 14.3	– 14.3
Book income	– 0.3	1.7	2.7	14.7	14.7	14.7	14.7
Book return on investment	– 0.0003	0.020	0.038	0.257	0.343	0.514	1.028
Book depreciation	14.3	14.3	14.3	14.3	14.3	14.3	14.3

Choice of a Measure

Which measure should a firm choose? Conceptually, the economic rate of return is superior to the book return on investment. In practice, however, the book return on investment is commonly employed as it can be calculated from the accounting information which is readily available. The change in book value can be easily observed but figuring out the change in economic value (present value), taking into account estimates of future cash flows (which may have to be revised periodically), is a lengthy process.

The book return on investment, though popular, suffers from two major shortcomings:

(i) It typically misrepresents true profitability, understating it in the earlier years and overstating it in the later years.

(ii) It may be vitiated by creative accounting.

The popularity of a flawed performance measurement seems to impair the quality of capital budgeting decisions. As the American Accounting Association Committee on Managerial Decision Models observed:

> The use of traditional accrual accounting methods for evaluating performance is a critical roadblock to implementation of present value models. Clearly, there is an inconsistency between citing present value models as being superior for capital budgeting decisions and then using entirely different concepts for tallying performance. As long as such practices persist, managers will often be tempted to make decisions which may be non-optimal under the present value criterion but optimal, at least over short or intermediate spans of time, under conventional accounting methods of evaluating operating performance.

Therefore, one should be aware of the limitations of accounting based measures.

ABANDONMENT ANALYSIS

Ordinarily, a project is analysed on the assumption that the firm will operate it for a given period. Often, however, it may be possible to abandon the project before this period. This possibility of abandonment, when considered explicitly in project analysis, may change the decision itself. To illustrate this point, let us look at the data on the expected cash flows and expected net abandonment values (which are nothing but net salvage values) for Project P given below.

Year	**Expected cash flow**	**Abandonment value**
0	(10,000)	(10,000)
1	4,000	6,200
2	3,800	4,000
3	3,600	–

The expected NPV over the three-year economic life, using a cost of capital of 10 per cent, is

$$NPV = -10{,}000 + \frac{4{,}000}{(1.10)} + \frac{3{,}800}{(1.10)^2} + \frac{3{,}600}{(1.10)^3} = -518.3$$

Thus, Project P would not be acceptable over the three-year economic life. What happens when we consider abandonment possibility at the end of year 2 or year 1? The expected net present values, associated with these possibilities, are as follows:

Abandonment at the end of year 2 $\quad NPV = -10{,}000 + \dfrac{4{,}000}{(1.10)} + \dfrac{3{,}800}{(1.10)^2} + \dfrac{4{,}000}{(1.10)^2} = -82.7$

Abandonment at the end of year 1 $\quad NPV = -10{,}000 + \dfrac{4{,}000}{(1.10)} + \dfrac{6{,}200}{(1.10)} = -727.3$

Thus, we find that this project has a negative expected net present value over a three-year period, a positive expected net present value over a two-year period, and a negative expected net present value over a one-year period. This suggests that the optimal economic life is two years and the project is worthwhile if it is abandoned after two years.

General Approach to Abandonment Analysis

As a general rule, a project must be abandoned if the present value of expected future cash flows associated with it, for all possible economic lives, is less than the current abandonment value. A step-by-step approach to operationalise this rule is given below:

1. Define the present value at time T of cash flows from the project over a period of x years (where x represents the period of abandonment)

$$PV_{T,x} = \sum_{t=T+1}^{x} \frac{A_t}{(1+k)^{t-T}} + \frac{AV_x}{(1+k)^{x-T}}$$

where $PV_{T,x}$ = present value at time T of expected cash flows through period x plus the present value of the expected abandonment value at the end of period x

A_t = expected cash flow at the end of year t

k = discount rate

AV_x = abandonment value expected at the end of period x

2. Set x equal to n (which represents the useful life of the project) and calculate $PV_{T,n}$

$$PV_{T,n} = \sum_{t=T+1}^{n} \frac{A_t}{(1+k)^{t-T}} + \frac{AV_n}{(1+k)^{n-T}}$$

3. Compare $PV_{T,n}$ with AV_T (abandonment value at time T). If $PV_{T,n} > AV_T$, hold the project and evaluate it at time $T+1$ based on the expectations at that time.
4. If $PV_{T,n} < AV_T$, calculate $PV_{T,n-1}$ (i.e., with x set equal to $n-1$) and compare it with AV_T.

   If $PV_{T,n-1} > AV_T$ hold the project and evaluate it at time $T+1$.
5. If $PV_{T,n-1} < AV_T$, calculate $PV_{T,n-2}$ (i.e., with x set equal to $n-2$) and compare it with AV_T. Continue this procedure till a decision to hold the project is arrived at or till x assumes a value of $T+1$.
6. If $PV_{T,x} < AV_T$ (for all values of x up to n), abandon the project at time T.

BEHAVIOURAL ISSUES IN PROJECT ABANDONMENT

A basic rule of capital budgeting says that investment decisions should be guided by the net present value criterion. Applied to a project 'continuation versus abandonment' decision, this rule says the project must be abandoned if the net present value associated with abandonment is greater than the net present value associated with continuation. By the same logic the project should be continued if the present value associated with continuation is greater than the net present value associated with abandonment.

Do managers follow the logic of net present value calculations in evaluating continuation versus abandonment decisions? It appears that they often overlook this logic. They have a tendency to get entrapped into losing projects and, in their attempts to rescue them, throw good money after bad. Why does this happen? While there can be several reasons, it happens mainly because sunk costs, which are irrelevant for economic accounting are often not ignored in mental accounting.

To illustrate the difference between economic accounting and mental accounting, consider the example of a person who having already lost Rs 20,000 in a business venture is confronted with a choice between two alternatives, *A* and *B*. Alternative *A* would yield a certain gain of Rs 10,000 whereas alternative *B*, akin to a gamble, has two equiprobable payoffs, 0 and Rs 20,000. If he employs the rules of economic accounting, he will form two accounts. The first contains a loss of Rs 20,000 and it is closed. The second involves a choice between *A* and *B* in which he would obviously choose *A* (as the expected value of *A* is same as that of *B* without the dispersion characterizing the latter). Put differently, a person who employs economic accounting will ignore sunk costs.

If he is guided by "mental accounting" he sees only one account that is open with an existing loss of Rs 20,000. Put in other words, he does not ignore sunk costs. Hence he views alternatives *A* and *B* as follows :

A. Closing the account with a loss of Rs 10,000. (The previous loss of Rs 20,000 less the gain of Rs 10,000.)

B. Closing the account with a loss of Rs 20,000 (if the pay-off of the gamble is zero) or a loss of nil (if the payoff of the gamble is Rs 20,000).

Kahneman and Tversky argue that people, confronted with a choice between a sure loss and a gamble which offers some prospect of reducing their loss to zero or so, tend to display risk-seeking behaviour.

A person who uses "mental accounting" does not adapt his asset position to losses and hence is likely to be entrapped in continuing the project. He distinguishes between unrealised 'paper losses' and realised 'losses' and adapts his asset position only after the losses are realised. Since realisation of losses induces regret, he is reluctant to realise them and resorts to procrastination as a way to defer the attendant pain. Of course, he may even deepen his commitment to the project further in the hope of finally emerging as a 'winner' and avoiding the ignominy of failure. In this context, note that commitment has a positive side as well as a negative side. On the positive side, it helps people to work harder, surmount obstacles, and scale great heights. On the negative side, it entraps people into negative *NPV* projects, induces them to throw good money after bad, and impairs their judgement.

Overcoming Resistance

Since the *NPV* prescription is clear, there is no intellectual difficulty in distinguishing projects where commitment is worthwhile from projects where it is not. The difficulty seems to arise because of a 'self control' problem. While the rational internal "principal" may understand the benefits of terminating a losing project, it may find it difficult to persuade the internal "agent" to take the desired action because termination means that a mental account has to be closed and the accompanying loss realised. To overcome this tendency the following measures may be used.

Follow Certain Rules Rules are useful in exercising self-control. Two rules that may be considered in the present context are:

- Evaluate the projects in conformity with the principles of economic accounting.
- Review all projects periodically to determine whether they should be terminated or continued in accordance with the *NPV* rule.

Develop Proper Rewards and Penalties If there are high rewards for success and high penalties for failure, project managers (or sponsors) may have a tendency to deepen their commitment (which may lead to entrapment) and also delay disclosure of bad news about the project. To counter such tendencies, the performance evaluation system of the company should (a) reward project managers who disclose bad news early and penalise projects managers who withhold bad news and (b) convey a message to project managers that some failures are normal in business and early steps should be initiated to cut losses.

Institute Relatively Independent Reviews Companies can develop formal structures whereby projects are periodically reviewed by people who are not members of the project team to determine whether they should be continued or terminated in accordance with the principles of economic accounting. Such reviews are likely to be more objective and unbiased.

ADMINISTRATIVE ASPECTS OF CAPITAL BUDGETING

The discussion of administrative aspects of capital budgeting has been organised as follows:

- Identification of promising investment opportunities
- Classification of investments

- Submission of proposals
- Decision making
- Preparation of capital budget and appropriation
- Implementation
- Performance review

Identification of Promising Investment Opportunities

Often firms have an abundance of investment proposals but a dearth of really worthwhile proposals. For identifying promising investment opportunities the following points should be borne in mind:

1. Monitor changes in market demand, sources of supply, profitability, competition, governmental policies, economic conditions, and technological developments.
2. Formulate long-range plans and perspectives based on analysis of opportunities and threats in the environment and assessment of internal strengths, weaknesses, capabilities, and limitations.
3. Communicate long range plans and corporate perspectives to all persons who are likely to be involved in capital budgeting.
4. Encourage employees to make suggestions and reward them suitably for valuable suggestions.

In short, the relationship between the firm and its environment should be regularly analysed, corporate plans and perspectives must be widely shared, and the creativity and imagination of the employees must be tapped.

With regard to tapping the imagination of employees, it may be noted that in most organisations personnel at middle and lower levels do not contribute much to the pool of investment proposals. This is often due to the failure of the administration to cull out good ideas emanating from different echelons of the organisation. To generate ideas, suggestion schemes are usually recommended. Suggestion schemes by themselves, however, cannot achieve the objective. According to John B. Mathews, Jr.:

> The solution seems to lie in that intangible thing known as 'climate', meaning in this case a receptivity to suggestions at all company levels and a pervading opinion that management has no monopoly on ideas and welcomes them from any and all sources.[2]

Classification

The classification of capital expenditure proposals refer to the grouping of similar proposals into separate categories. Classification helps in decision making, budgeting, and control.

Investment proposals may be classified in many ways. We suggest below a scheme of classification which can with minor modification be adopted for most manufacturing enterprises:

1. *Replacement Investments* These represent capital expenditures for the replacement of existing fixed assets—this may become necessary because of the expiry of normal life or because of a change in technology.

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[2] J.B. Mathews, Jr. "How to Administer Capital Spending," *Harvard Business Review*, March-April, 1959.

2. *Modernisation and Rationalisation Investments* These comprise capital expenditures for improving productivity, increasing efficiency, reducing costs, and ensuring greater reliability.
3. *Expansion Investments* These represent capital expenditures for increasing capacity.
4. *New Product Investments* These represent capital expenditures to manufacture new products.
5. *Research and Development Investments* These represent capital expenditures on basic research and development facilities.
6. *Obligatory and Welfare Investments* These represent expenditures on facilities which are obligatory and/or conducive to employee welfare.

Submission of Proposals

To ensure that all relevant information for proposals is gathered systematically, a standardised proposal form may be used by all the sponsors of investment projects. A suggested proposal form is shown in Exhibit 20.3.

To help the sponsor of the project in filling and submitting the form:

1. A procedures manual setting forth in detail the firm's capital budgeting policy and techniques may be prepared and widely disseminated.
2. Short duration training programmes may be organised.
3. The help of a staff person may be made available to the sponsor of the project.

The proposal form before it reaches the capital budgeting committee should normally be routed through persons who can comment on the estimates furnished by the sponsor. The routing channel, however, cannot be standardised. It will vary from one organisation to another and, perhaps, from one proposal to another.

EXHIBIT 20.3

Capital Investment Proposal Form

(Useful particularly for replacement, modernisation, rationalisation, expansion, and new product investments.)

Sponsor's Name:	Date:
Sponsor's Signature:	Code No: (To be given by capital budgeting committee.)

Department:
Proposal:

A. *Project Features and Nature of Benefits*
(Describe the nature of the project and the kinds of benefits, both quantitative and qualitative, that are likely to accrue from it.)

B. *Cash Flow Summary Data*
(Give most probable values for cash flows. Cash flows must be defined consistently with the concept of funds employed. Show details of the cash flow calculation in an appendix.)

Period	Outlay for assets	Cash flow from operations	Cash flow from disposal of assets	Net cash flow
0				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

C. *Risk Characteristics of the Project*

(Describe the uncertainties relating to factors which have an important bearing on the project.)

D. *Project Worthwhileness Measures*

(Several criteria of project worthwhileness are given below. It may not be necessary to calculate all criteria of worthwhileness in every case. However, at least one discounted cash flow method should be given.)

1. (i) Net present value at average cost of capital ($k = 10\%$ say)
   (ii) Net present value at cost of capital adjusted for risk ($k = 12\%$ say)
2. Internal rate of return
3. Profitability index
4. Accounting rate of return
5. Cash payback period
6. Undiscounted benefit cost ratio

E. *Comments of Reviewing Officers*

(Reviewing Officers are expected to give their frank and candid opinion about the project. They may seek clarification from the sponsor, if necessary.)

	Reviewing Officer	Initials	Date
1.			
2.			
3.			
4.			

Space for Comments

Reviewing Officer 1

Reviewing Officer 2

Reviewing Officer 3

Reviewing Officer 4

Routing a proposal through several persons provides a mechanism for obtaining the views and judgements of others. For example, a proposal submitted by the plant superintendent may be routed through the production manager, sales manager, and engineering manager for their comments on different aspects of the project. This also facilitates coordination of inter-related activities. Obviously this system would yield benefits only when the persons through whom the proposal is routed give thought to it rather than merely forward it in a routine manner.

Decision Making

It may be argued that the optimal capital budget for the firm as a whole can be drawn up only when capital investment decisions are completely centralised. This, however, is not desirable in most cases because some decentralisation is required to facilitate quick decisions, develop executives, and conserve top management time for important matters. That is why most of the companies empower executives at different levels to take investment decisions involving outlays up to certain limits. In one company, for example, the plant superintendent can okay investment outlays up to Rs 5,000, the factory manager up to Rs 10,000, the capital budgeting committee up to Rs 25,000, and the managing director up to Rs 50,000. Investments involving larger outlays need the consent of the board of directors.

While the system of rupee gateways has considerable merit there may be certain pitfalls. Managers may break a project into several parts so that no decision at a higher level becomes necessary. For example, a production manager who is empowered to undertake a project up to Rs 10,000 may split a project involving an outlay of Rs 15,000 into two parts of Rs 8,000 and Rs 7,000 so that it is not sent upwards for review. This tendency can be countered by asking managers, when they seek budgetary appropriations, to indicate the additional investment required in related areas in future.

Another problem in the delegation of capital investment decision making arises from differences in risk attitudes. Managers at lower levels tend to be more averse to risks than top management. They may discard projects which top management may approve. This tendency can be overcome to some extent by communicating corporate strategy and risk disposition of top management to all those who are involved in capital budgeting. In addition, lower level executives should be encouraged to take risks consistent with corporate policy by designing an appropriate system of rewards and punishment.

Preparation of Capital Budget and Appropriation

Smaller projects which can be approved at lower levels may be covered by a blanket appropriation so that they can be undertaken expeditiously. Since these projects require small outlays, no elaborate funds planning is required for them. Projects of larger magnitude (which generally required the approval of the capital budget committee or Managing Director or the Board of Directors) may be included after approval in the tentative capital budget. The final capital budget, which serves as the basis of budgetary appropriations, should be drawn up after the availability of funds is ensured. Often careful planning of funds is required before budgetary appropriations are made.

While the capital expenditure budget is usually drawn up for one to two years, it is desirable to have a perspective plan ranging from 3 to 5 years. In some cases it may even be of a longer duration.

The capital expenditure budget, though it is based on a careful review of various factors, should not be regarded inviolate. Changes in circumstances may warrant changes in the budget not originally contemplated. This is perhaps the reason why a final sanction is required before actual expenditure in many companies.

The coordination of the capital expenditure budget should preferably be done by a financial officer of the firm. In firms where a financial officer is not in charge of coordination, the budgetary process and the analysis of individual projects tend to be somewhat loose and sloppy.

Implementation

Delays in implementation and consequent increases in project cost are very common. Cases are not infrequent where the actual time for execution has exceeded planned time by 50 per cent. Cost over-runs are also very common. In many cases over-runs have been between 30 per cent and 100 per cent. These facts emphasise the need for expeditious implementation at a reasonable cost. For this the following points are helpful:

1. *Adequate formulation of projects*

   Often delays occur because of insufficient preliminary studies and inadequate formulation of the project. Wit the following :

   > Cases have come to notice where due to inadequate or limited investigation in regard to suitability of site, availability of required natural resources, other raw materials, etc. the execution of project has subsequently been delayed considerably resulting in substantial increase in cost and adversely affecting their economies.

   Such delays can be mitigated by bestowing greater care and attention on preliminary investigations and project formulation. The responsibility of investigation should be properly determined.

2. *Use of the principle of responsibility accounting*

   By assigning definite responsibilities to project managers for completing the project on time, a sense of time consciousness can be instilled. This helps in expeditious implementation.

3. *Use of network techniques*

   Network techniques like PERT (Programme Evaluation Review Technique) and CPM (Critical Path Method) are helpful in project planning and control. With the help of these techniques, progress reporting becomes rather easy. Precise, prompt, and brief reports aid the management in appraisal and corrective action so as to ensure successful completion of projects.

4. *Exercise of proper control*

   Once an appropriation is established the sponsor (or manager) of the project is authorised to incur expenditure. Proper control over this expenditure needs to be exercised. Periodical reports on expenditure along with information on the degree of physical completion are helpful in this respect. It should be noted that unless information regarding physical completion is available control becomes difficult.

Performance Reviews

Performance review is meant for evaluating actual performance vis-a-vis projected performance. It is concerned with the verification of assumptions regarding both revenues and costs. In scope, it is broader than the popularly used accounting review which is concerned only with costs.

Despite its importance, performance review is one of the most neglected aspects of capital budgeting. The reasons seem to be:

- It is difficult to isolate the cash flows attributable to individual investments from financial accounts which are compiled for the firm as a whole and which are based on the accrual principle.
- There is an apprehension that a performance review may be used for punitive purposes.

The first problem can be overcome largely by using estimates and approximations wherever it is not possible to obtain accurate data. For example, if costs relating to a project have not been recorded separately, a reasonable estimate can usually be made on the basis of information relating to total costs and the activities of the firm. Likewise cash flows from sales arising from a project can be roughly estimated by looking into the collection pattern of receivables as a whole.

The second problem can be overcome by making it clear to all project sponsors that the purpose of postaudit is to promote learning and not to penalise the persons involved. It provides feedback that is necessary for future improvements.

EVALUATING THE CAPITAL BUDGETING SYSTEM OF AN ORGANISATION

The soundness of the capital budgeting system of an organisation may be evaluated in terms of the following criteria:

Results	Are the results of the capital budgeting system consistent with the goals of the organisation?
Techniques	Are efficient techniques being employed for purposes of capital expenditure planning, decision making, and control?
Communication	Are the premises underlying capital budgeting communicated to those who participate in this process?
Decentralisation	Is there meaningful delegation and decentralisation which permits decision making at appropriate levels?
Intelligibility	Are the policies, methods of analysis, and procedures understood by different segments of the organisation which are involved in capital budgeting?
Flexibility	Does the system have sufficient flexibility to respond to the dynamic changes in the environment and to permit variations in approaches for projects with differing characteristics?
Control	Are adequate controls being exercised in the implementation phases to ensure that slippages are mitigated?

Review	Is there a systematic review of capital investments which permits meaningful feedback for improving the system and its effectiveness?

SUMMARY

- To ensure that the actual expenditure on a project does not deviate significantly from the authorised expenditure, periodic control is exercised during project implementation.
- An audit of a project after it has been commissioned is referred to as postaudit or post completion audit. Most firms do a postaudit for projects above some threshold limit.
- While the postaudit is typically a one-time exercise, performance evaluation is done periodically. It seeks to measure the performance of the project on an ongoing basis. Performance evaluation may be done in terms of economic rate of return or book return on investment.
- Existing projects need to be evaluated periodically to determine whether they should be continued or abandoned. As a general rule, a project must be abandoned if the present value of expected future cash flows associated with it, for all possible economic lives, is less than the current abandonment net value.
- It appears that managers often overlook the logic of net present value in evaluating "continuation versus abandonment" decisions and have a tendency to get entrapped into losing projects. To overcome this tendency, the following measures may be used: (i) follow certain rules, (ii) develop proper rewards and penalties, and (iii) institute relatively independent reviews.
- For identifying promising investment opportunities, the relationship between the firm and its environment should be regularly analysed, corporate plans and perspectives must be widely shared, and the creativity and imagination of the employees must be tapped.
- Investment proposals may be classified in many ways. The following scheme of classification can with minor modification be adopted for most manufacturing enterprises: (i) replacement investments, (ii) modernisation and rationalisation investments, (iii) expansion investments, (iv) new product investments, (v) research and development investments, and (vi) obligatory and welfare investments.
- To ensure that all relevant information for proposals is gathered systematically, a standardised proposal form may be used by all the sponsors of investment projects.
- Some decentralisation of capital budgeting is required to facilitate quick decisions, develop executives, and conserve top management time for important matters. That is why most companies empower executives at different levels to take investment decisions involving outlays up to certain limits.
- While the capital expenditure budget is usually drawn up for one to two years, it is desirable to have a perspective plan ranging from 3 to 5 years. In some cases it may even be of a longer duration. The coordination of the capital expenditure budget should preferably be done by a financial officer of the firm.
- For timely implementation of projects within reasonable costs, the following are helpful: adequate formulation of projects; use of the principle of responsibility accounting; use of network techniques; and exercise of proper control.

- Despite its importance, performance review tends to be one of the most neglected aspects of capital budgeting.
- The soundness of the capital budgeting system of an organisation may be evaluated in terms of the following criteria: results, techniques, communication, decentralisation, intelligibility, flexibility, control, and review.

QUESTIONS

1. Why should postaudit be done? When should postaudit be done? Who should do postaudit?
2. What is the difference between economic rate of return and book return on investment?
3. Describe the general procedure for abandonment analysis.
4. What is the difference between economic accounting and mental accounting?
5. Discuss measures for injecting greater rationality in project termination decisions.
6. What needs to be done to identify potential investment opportunities?
7. Suggest a scheme for classifying capital expenditure proposals in a manufacturing concern.
8. "The optimal capital budget for the firm as a whole can be drawn up only when capital investment decisions are completely centralised." Comment.
9. What are the advantages of conducting a performance review? What problems are encountered in performance review and how can they be overcome?
10. How would you evaluate the capital budgeting system of an organisation?

PROBLEMS

1. Prabhat Limited is considering a project involving an outlay of Rs 150 million. The projected cash inflows of this project over its 6-year life are as follows:

Year	**1**	**2**	**3**	**4**	**5**	**6**
Cash inflow (Rs in million)	25	30	40	45	50	30

This investment is a zero-*NPV* investment. Calculate the economic rate of return and the book return on income (assuming a straight line depreciation over the 6-year life) for the above project.

2. The expected cash flows and expected net abandonment values for a project are given below:

Year	**Expected cash flow**	**Abandonment value**
0	(100,000)	(100,000)
1	35,000	70,000
2	32,000	45,000
3	30,000	18,000
4	25,000	

When should this project be abandoned?

APPENDIX A

TABLE A.1

Future Value Interest Factor (*FVIF*)

$FVIF(k,n) = (1+k)^n$

Period *n*	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%
0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1	1.010	1.020	1.030	1.040	1.050	1.060	1.070	1.080	1.090	1.100	1.110	1.120	1.130
2	1.020	1.040	1.061	1.082	1.102	1.124	1.145	1.166	1.188	1.210	1.232	1.254	1.277
3	1.030	1.061	1.093	1.125	1.158	1.191	1.225	1.260	1.295	1.331	1.368	1.405	1.443
4	1.041	1.082	1.126	1.170	1.216	1.262	1.311	1.360	1.412	1.464	1.518	1.574	1.630
5	1.051	1.104	1.159	1.217	1.276	1.338	1.403	1.469	1.539	1.611	1.685	1.762	1.842
6	1.062	1.126	1.194	1.265	1.340	1.419	1.501	1.587	1.677	1.772	1.870	1.974	2.082
7	1.072	1.149	1.230	1.316	1.407	1.504	1.606	1.714	1.828	1.949	2.076	2.211	2.353
8	1.083	1.172	1.267	1.369	1.477	1.594	1.718	1.851	1.993	2.144	2.305	2.476	2.658
9	1.094	1.195	1.305	1.423	1.551	1.689	1.838	1.999	2.172	2.358	2.558	2.773	3.004
10	1.105	1.219	1.344	1.480	1.629	1.791	1.967	2.159	2.367	2.594	2.839	3.106	3.395
11	1.116	1.243	1.384	1.539	1.710	1.898	2.105	2.332	2.580	2.853	3.152	3.479	3.836
12	1.127	1.268	1.426	1.601	1.796	2.012	2.252	2.518	2.813	3.138	3.498	3.896	4.335
13	1.138	1.294	1.469	1.665	1.886	2.133	2.410	2.720	3.056	3.452	3.883	4.363	4.898
14	1.149	1.319	1.513	1.732	1.930	2.261	2.579	2.937	3.342	3.797	4.310	4.887	5.535
15	1.161	1.346	1.558	1.801	2.079	2.397	2.759	3.172	3.642	4.177	4.785	5.474	6.254
16	1.173	1.373	1.605	1.873	2.183	2.540	2.952	3.426	3.970	4.595	5.311	6.130	7.067
17	1.184	1.400	1.653	1.948	2.292	2.693	3.159	3.700	4.328	5.054	5.895	6.866	7.986
18	1.196	1.428	1.702	2.026	2.407	2.854	3.380	3.996	4.717	5.560	6.544	7.690	9.024
19	1.208	1.457	1.754	2.107	2.527	3.026	3.617	4.316	5.142	6.116	7.263	8.613	10.197
20	1.220	1.486	1.806	2.191	2.653	3.207	3.870	4.661	5.604	6.728	8.062	9.646	11.523
25	1.282	1.641	2.094	2.666	3.386	4.292	5.427	6.848	8.623	10.835	13.585	17.000	21.231
30	1.348	1.811	2.427	3.243	4.322	5.743	7.612	10.063	13.268	17.449	22.892	29.960	39.116

Period *n*	14%	15%	16%	17%	18%	19%	20%	24%	28%	32%	36%	40%
0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1	1.140	1.150	1.160	1.170	1.180	1.190	1.200	1.240	1.280	1.320	1.360	1.400
2	1.300	1.322	1.346	1.369	1.392	1.416	1.440	1.538	1.638	1.742	1.850	1.960
3	1.482	1.521	1.561	1.602	1.643	1.685	1.728	1.907	2.097	2.300	2.515	2.744
4	1.689	1.749	1.811	1.874	1.939	2.005	2.074	2.364	2.684	3.036	3.421	3.842
5	1.925	2.011	2.100	2.192	2.288	2.386	2.488	2.392	3.436	4.007	4.653	5.378
6	2.195	2.313	2.436	2.565	2.700	2.840	2.986	3.635	4.398	5.290	6.328	7.530
7	2.502	2.660	2.826	3.001	3.185	3.379	3.583	4.508	5.629	6.983	8.605	10.541
8	2.853	3.059	3.278	3.511	3.759	4.021	4.300	5.590	7.206	9.217	11.703	14.758
9	3.252	3.518	3.803	4.108	4.435	4.785	5.160	6.931	9.223	12.166	15.917	20.661
10	3.707	4.046	4.411	4.807	5.234	5.695	6.192	8.594	11.806	16.060	21.647	28.925
11	4.226	4.652	5.117	5.624	6.176	6.777	7.430	10.657	15.112	21.199	29.439	40.496
12	4.818	5.350	5.936	6.580	7.288	8.064	8.916	13.215	19.343	27.983	40.037	56.694
13	5.492	6.153	6.886	7.699	8.599	9.596	10.699	16.386	24.759	36.937	54.451	79.372
14	6.261	7.076	7.988	9.007	10.147	11.420	12.839	20.319	31.961	48.757	74.053	111.120
15	7.138	8.137	9.266	10.539	11.974	13.590	15.407	25.196	40.565	64.359	100.712	155.568
16	8.137	9.358	10.748	12.330	14.129	16.172	18.488	31.243	51.923	84.954	136.969	217.795
17	9.276	10.761	12.468	14.426	16.672	19.244	22.186	38.741	66.461	112.139	186.278	304.914
18	10.575	12.375	14.463	16.879	19.673	22.901	26.623	48.039	85.071	148.023	253.338	426.879
19	12.056	14.232	16.777	19.748	23.214	27.252	31.948	59.568	108.890	195.391	344.540	597.630
20	13.743	16.367	19.461	23.106	27.393	32.429	38.338	73.864	139.380	257.916	468.574	836.683
25	26.462	32.919	40.874	50.658	62.669	77.388	95.396	216.542	478.905	1033.590	2180.081	4499.880
30	50.950	66.212	85.850	111.065	143.371	184.675	237.376	634.820	1645.504	4142.075	10143.019	24201.432

TABLE A.2

Future Value Interest Factor for an Annuity

$$FVIFA(k, n) = \frac{(1+k)^n - 1}{k}$$

Period n	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%
1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2	2.010	2.020	2.030	2.040	2.050	2.060	2.070	2.080	2.090	2.100	2.110	2.120	2.130
3	3.030	3.060	3.091	3.122	3.152	3.184	3.215	3.246	3.278	3.310	3.342	3.374	3.407
4	4.060	4.122	4.184	4.246	4.310	4.375	4.440	4.506	4.573	4.641	4.710	4.779	4.850
5	5.101	5.204	5.309	5.416	5.526	5.637	5.751	5.867	5.985	6.105	6.228	6.353	6.480
6	6.152	6.308	6.468	6.633	6.802	6.975	7.153	7.336	7.523	7.716	7.913	8.115	8.323
7	7.214	7.434	7.662	7.898	8.142	8.394	8.654	8.923	9.200	9.487	9.783	10.089	10.405
8	8.286	8.583	8.892	9.214	9.549	9.897	10.260	10.637	11.028	11.436	11.859	12.300	12.757
9	9.369	9.755	10.159	10583	11.027	11.491	11.978	12.488	13.021	13.579	14.164	14.776	15.416
10	10.462	10.950	11.464	12.006	12.578	13.181	13.816	14.487	15.193	15.937	16.722	17.549	18.420
11	11.567	12.169	12.808	13.486	14.207	14.972	15.784	16.645	17.560	18.531	19.561	20.655	21.814
12	12.683	13.412	14.192	15.026	15.917	16.870	17.888	18.977	20.141	21.384	22.713	24.133	25.650
13	13.809	14.680	15.618	16.627	17.713	18.882	20.141	21.495	22.953	24.523	26.212	28.029	29.985
14	14.947	15.974	17.086	18.292	19.599	21.015	22.550	24.215	26.019	27.975	30.095	32.393	34.883
15	16.097	17.293	18.599	20.024	21.579	23.276	25.129	27.152	29.361	31.772	34.405	37.280	40.417
16	17.258	18.639	20.157	21.825	23.657	25.673	27.888	30.324	33.003	35.950	39.190	42.753	46.672
17	18.430	20.012	21.762	23.698	25.840	28.213	30.840	33.750	36.974	40.545	44.501	48.884	53.739
18	19.615	21.412	23.414	25.645	28.132	30.906	33.999	37.450	41.301	45.599	50.396	55.750	61.725
19	20.811	22.841	25.117	27.671	30.539	33.760	37.379	41.446	46.018	51.159	56.939	63.440	70.749
20	22.019	24.297	26.870	29.778	33.066	36.786	40.995	45.762	51.160	57.275	64.203	72.052	80.947
25	28.243	32.030	36.459	41.646	47.727	54.865	63.249	73.106	84.701	98.347	114.413	133.334	155.620
30	34.785	40.568	47.575	56.805	66.439	79.058	94.461	113.283	136.308	164.494	199.021	241.333	293.199

Period *n*	14%	15%	16%	17%	18%	19%	20%	24%	28%	32%	36%	40%
1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2	2.140	2.150	2.160	2.170	2.180	2.190	2.200	2.240	2.280	2.320	2.360	2.400
3	3.440	3.473	3.506	3.539	3.572	3.606	3.640	3.778	3.918	4.062	4.210	4.360
4	4.921	4.993	5.066	5.141	5.215	5.291	5.368	5.684	6.016	6.362	6.725	7.104
5	6.610	6.742	6.877	7.014	7.154	7.297	7.442	8.048	8.700	9.398	10.146	10.946
6	8.536	8.754	8.977	9.207	9.442	9.683	9.930	10.980	12.136	13.406	14.799	16.324
7	10.730	11.067	11.414	11.772	12.142	12.523	12.916	14.615	16.534	18.696	21.126	23.853
8	13.233	13.727	14.240	14.773	15.327	15.902	16.499	19.123	22.163	25.678	29.732	34.395
9	16.085	16.786	17.518	18.285	19.086	19.923	20.799	24.712	29.369	34.895	41.435	49.153
10	19.337	20.304	21.321	22.393	23.521	24.709	25.959	31.643	38.592	47.062	57.352	69.814
11	23.044	24.349	25.733	27.200	28.755	30.404	32.150	40.238	50.399	63.122	78.998	98.739
12	27.271	29.002	30.850	32.824	34.931	37.180	39.580	50.985	65.510	84.320	108.437	139.235
13	32.089	34.352	36.786	39.404	42.219	45.244	48.497	64.110	84.853	112.303	148.475	195.929
14	37.581	40.505	43.672	47.103	50.818	54.841	59.196	80.496	109.612	149.240	202.926	275.300
15	43.842	27.580	51.660	56.110	60.965	66.261	72.035	100.815	141.303	197.997	276.979	386.420
16	50.980	55.717	60.925	66.649	72.939	79.850	87.442	126.011	181.868	262.356	377.692	541.988
17	59.118	65.075	71.673	78.979	87.068	96.022	105.931	157.253	233.791	347.310	514.661	759.784
18	68.394	75.836	84.141	93.406	103.740	115.266	128.117	195.994	300.252	459.449	700.939	1064.697
19	78.969	88.212	98.603	110.285	123.414	138.166	154.740	244.033	385.323	607.472	954.277	1491.576
20	91.025	102.44	115.380	130.033	146.628	165.418	186.688	303.601	494.213	802.863	1298.817	2089.206
25	181.871	212.793	249.214	292.105	342.603	402.042	471.981	898.092	1706.803	3226.844	6053.004	11247.199
30	356.787	434.745	530.321	647.439	790.948	966.712	1181.882	2640.916	5873.231	12940.859	28172.276	60501.081

TABLE A.3

Present Value Interest Factor

$PVIF(k, n) = (1 + k)^{-n}$

Period n	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%
0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1	0.990	0.980	0.971	0.962	0.952	0.943	0.935	0.926	0.917	0.909	0.901	0.893	0.885
2	0.980	0.961	0.943	0.925	0.907	0.890	0.873	0.857	0.842	0.826	0.812	0.797	0.783
3	0.971	0.942	0.915	0.889	0.864	0.840	0.816	0.794	0.772	0.751	0.731	0.712	0.693
4	0.961	0.924	0.889	0.855	0.823	0.792	0.763	0.735	0.708	0.683	0.659	0.636	0.613
5	0.951	0.906	0.863	0.822	0.784	0.747	0.713	0.681	0.650	0.621	0.593	0.567	0.543
6	0.942	0.888	0.838	0.790	0.746	0.705	0.666	0.630	0.596	0.564	0.535	0.507	0.480
7	0.933	0.871	0.813	0.760	0.711	0.665	0.623	0.583	0.547	0.513	0.482	0.452	0.425
8	0.923	0.853	0.789	0.731	0.677	0.627	0.582	0.540	0.502	0.467	0.434	0.404	0.376
9	0.914	0.837	0.766	0.703	0.645	0.592	0.544	0.500	0.460	0.424	0.391	0.361	0.333
10	0.905	0.820	0.744	0.676	0.614	0.558	0.508	0.463	0.422	0.386	0.352	0.322	0.295
11	0.896	0.804	0.722	0.650	0.585	0.527	0.475	0.429	0.388	0.350	0.317	0.287	0.261
12	0.887	0.788	0.701	0.625	0.557	0.497	0.444	0.397	0.356	0.319	0.286	0.257	0.231
13	0.879	0.773	0.681	0.601	0.530	0.469	0.415	0.368	0.326	0.290	0.258	0.229	0.204
14	0.870	0.758	0.661	0.577	0.505	0.442	0.388	0.340	0.299	0.263	0.232	0.205	0.181
15	0.861	0.743	0.642	0.555	0.481	0.417	0.362	0.315	0.275	0.239	0.209	0.183	0.160
16	0.853	0.728	0.623	0.534	0.458	0.394	0.339	0.292	0.252	0.218	0.188	0.163	0.141
17	0.844	0.714	0.605	0.513	0.436	0.371	0.317	0.270	0.231	0.198	0.170	0.146	0.125
18	0.836	0.700	0.587	0.494	0.416	0.350	0.296	0.250	0.212	0.180	0.153	0.130	0.111
19	0.828	0.686	0.570	0.475	0396	0.331	0.276	0.232	0.194	0.164	0.138	0.116	0.098
20	0.820	0.673	0.554	0.456	0.377	0.312	0.258	0.215	0.178	0.149	0.124	0.104	0.087
25	0.780	0.610	0.478	0.375	0.295	0.233	0.184	0.146	0.116	0.092	0.074	0.059	0.047
30	0.742	0.552	0.412	0.308	0.231	0.174	0.131	0.099	0.075	0.057	0.044	0.033	0.026

Period n	14%	15%	16%	17%	18%	19%	20%	24%	28%	32%	36%	40%
0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1	0.877	0.870	0.862	0.855	0.847	0.840	0.833	0.806	0.781	0.758	0.735	0.714
2	0.769	0.756	0.743	0.731	0.718	0.706	0.694	0.650	0.610	0.574	0.541	0.510
3	0.675	0.658	0.641	0.624	0.609	0.593	0.579	0.524	0.477	0.435	0.398	0.364
4	0.592	0.572	0.552	0.534	0.516	0.499	0.482	0.423	0.373	0.329	0.292	0.260
5	0.519	0.497	0.476	0.456	0.437	0.419	0.402	0.341	0.291	0.250	0.215	0.186
6	0.456	0.432	0.410	0.390	0.370	0.352	0.335	0.275	0.227	0.189	0.158	0.133
7	0.400	0.376	0.354	0.333	0.314	0.296	0.279	0.222	0.178	0.143	0.116	0.095
8	0.351	0.327	0.305	0.285	0.266	0.249	0.233	0.179	0.139	0.108	0.085	0.068
9	0.308	0.284	0.263	0.243	0.226	0.209	0.194	0.144	0.108	0.082	0.063	0.048
10	0.270	0.247	0.227	0.208	0.191	0.176	0.162	0.116	0.085	0.062	0.046	0.035
11	0.237	0.215	0.195	0.178	0.162	0.148	0.135	0.094	0.066	0.047	0.034	0.025
12	0.208	0.187	0.168	0.152	0.137	0.124	0.112	0.076	0.052	0.036	0.025	0.018
13	0.182	0.163	0.145	0.130	0.116	0.104	0.093	0.061	0.040	0.027	0.018	0.013
14	0.160	0.141	0.125	0.111	0.099	0.088	0.078	0.049	0.032	0.021	0.014	0.009
15	0.140	0.123	0.108	0.095	0.084	0.074	0.065	0.040	0.025	0.016	0.010	0.006
16	0.123	0.107	0.093	0.081	0.071	0.062	0.054	0.032	0.019	0.012	0.007	0.005
17	0.108	0.093	0.080	0.069	0.060	0.052	0.045	0.026	0.015	0.009	0.005	0.003
18	0.095	0.081	0.069	0.059	0.051	0.044	0.038	0.021	0.012	0.007	0.004	0.002
19	0.083	0.070	0.060	0.051	0.043	0.037	0.031	0.017	0.009	0.005	0.003	0.002
20	0.073	0.061	0.051	0.043	0.037	0.031	0.026	0.014	0.007	0.004	0.002	0.001
25	0.038	0.030	0.024	0.020	0.016	0.013	0.010	0.005	0.002	0.001	0.000	0.000
30	0.020	0.015	0.012	0.009	0.007	0.005	0.004	0.002	0.001	0.000	0.000	0.000

TABLE A.4

Present Value Interest Factor for an Annuity

$$PVIFA(k, n) = \frac{1 - \frac{1}{(1+k)^n}}{k}$$

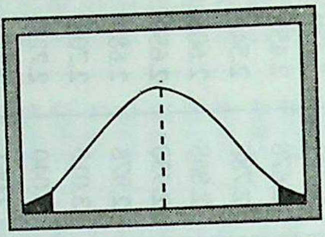
Period n	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%
0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1	0.990	0.980	0.971	0.962	0.952	0.943	0.935	0.926	0.917	0.909	0.901	0.893	0.885
2	1.970	1.942	1.913	1.886	1.859	1.833	1.808	1.783	1.759	1.736	1.713	1.690	1.668
3	2.941	2.884	2.829	2.775	2.723	2.673	2.624	2.577	2.531	2.487	2.444	2.402	2.361
4	3.902	3.808	3.717	3.630	3.546	3.465	3.387	3.312	3.240	3.170	3.102	3.037	2.974
5	4.853	4.713	4.580	4.452	4.329	4.212	4.100	3.993	3.890	3.791	3.696	3.605	3.517
6	5.795	5.601	5.417	5.242	5.076	4.917	4.766	4.623	4.486	4.355	4.231	4.111	3.998
7	6.728	6.472	6.230	6.002	5.786	5.582	5.389	5.206	5.033	4.868	4.712	4.564	4.423
8	7.652	7.325	7.020	6.733	6.463	6.210	5.971	5.747	5.535	5.335	5.146	4.968	4.799
9	8.566	8.162	7.786	7.435	7.108	6.802	6.515	6.247	5.995	5.759	5.537	5.328	5.132
10	9.471	8.983	8.530	8.111	7.722	7.360	7.024	6.710	6.418	6.145	5.889	5.650	5.426
11	10.368	9.787	9.253	8.760	8.306	7.887	7.499	7.139	6.805	6.495	6.207	5.938	5.687
12	11.255	10.575	9.954	9.385	8.863	8.384	7.943	7.536	7.161	6.814	6.492	6.194	5.918
13	12.134	11.348	10.635	9.986	9.394	8.853	8.358	7.904	7.487	7.103	6.750	6.424	6.122
14	13.004	12.106	11.296	10.563	9.899	9.295	8.745	8.244	7.786	7.367	6.982	6.628	6.302
15	13.865	12.849	11.938	11.118	10.380	9.712	9.108	8.559	8.060	7.606	7.191	6.811	6.462
16	14.718	13.578	12.561	11.652	10.838	10.106	9.447	8.851	8.312	7.824	7.379	6.974	6.604
17	15.562	14.292	13.166	12.166	11.274	10.477	9.763	9.122	8.544	8.022	7.549	7.120	6.729
18	16.398	14.992	13.754	12.659	11.690	10.828	10.059	9.372	8.756	8.201	7.702	7.250	6.840
19	17.226	15.678	14.324	13.134	12.085	11.158	10.336	9.604	8.950	8.365	7.839	7.366	6.938
20	18.046	16.351	14.877	13.590	12.462	11.470	10.594	9.818	9.128	8.514	7.963	7.469	7.025
25	22.023	19.523	17.413	15.622	14.094	12.783	11.654	10.675	9.823	9.077	8.422	7.843	7.330
30	25.808	22.397	19.600	17.292	15.373	13.765	12.409	11.258	10.274	9.427	8.694	8.055	7.496

Period n	14%	15%	16%	17%	18%	19%	20%	24%	28%	32%	36%	40%
0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1	0.877	0.870	0.862	0.855	0.847	0.840	0.833	0.806	0.781	0.758	0.735	0.714
2	1.647	1.626	1.605	1.585	1.566	1.547	1.528	1.457	1.392	1.332	1.276	1.224
3	2.322	2.283	2.246	2.210	2.174	2.140	2.106	1.981	1.868	1.766	1.674	1.589
4	2.914	2.855	2.798	2.743	2.690	2.639	2.589	2.404	2.241	2.096	1.966	1.849
5	3.433	3.352	3.274	3.199	3.127	3.058	2.991	2.745	2.532	2.345	2.181	2.035
6	3.889	3.784	3.685	3.589	3.498	3.410	3.326	3.020	2.759	2.534	2.339	2.168
7	4.288	4.160	4.039	3.922	3.812	3.706	3.605	3.242	2.937	2.678	2.455	2.263
8	4.639	4.487	4.344	4.207	4.078	3.954	3.837	3.421	3.076	2.786	2.540	2.331
9	4.946	4.772	4.607	4.451	4.303	4.163	4.031	3.566	3.184	2.868	2.603	2.379
10	5.216	5.019	4.883	4.659	4.494	4.339	4.193	3.682	3.269	2.930	2.650	2.414
11	5.453	5.234	5.029	4.836	4.656	4.486	4.327	3.776	3.335	2.978	2.683	2.438
12	5.660	5.421	5.197	4.988	4.793	4.611	4.439	3.851	3.387	3.013	2.708	2.456
13	5.842	5.583	5.342	5.118	4.910	4.715	4.533	3.912	3.427	3.040	2.727	2.469
14	6.002	5.724	5.468	5.229	5.008	4.802	4.611	3.962	3.459	3.061	2.740	2.478
15	6.142	5.847	5.575	5.324	5.092	4.876	4.675	4.001	3.483	3.076	2.750	2.484
16	6.265	5.954	5.669	5.405	5.162	4.938	4.730	4.033	3.503	3.088	2.758	2.489
17	6.373	6.047	5.749	5.475	5.222	4.990	4.775	4.059	3.518	3.097	2.763	2.492
18	6.647	6.128	5.818	5.534	5.273	5.033	4.812	4.080	3.529	3.104	2.767	2.494
19	6.550	6.198	5.877	5.584	5.316	5.070	4.844	4.097	3.539	3.109	2.770	2.496
20	6.623	6.259	5.929	5.628	5.353	5.101	4.870	4.110	3.546	3.113	2.772	2.497
25	6.873	6.464	6.097	5.766	5.467	5.195	4.948	4.147	3.564	3.122	2.776	2.499
30	7.003	6.566	6.177	5.829	5.517	5.235	4.979	4.160	3.569	3.124	2.778	2.500

TABLE A.5

Normal Distribution

(Area of the Normal Distribution, that is, Z Standard Deviations to the Left or Right of the Mean)



Number of standard deviations from mean (Z)	Area to the left or right (One tail)	Number of standard deviations from mean (Z)	Area to the left or right (One tail)
0.00	0.5000	1.70	0.0446
0.05	0.4801	1.75	0.0401
0.10	0.4602	1.80	0.0359
0.15	0.4404	1.85	0.0322
0.20	0.4207	1.90	0.0287
0.25	0.4013	1.95	0.0256
0.30	0.3821	2.00	0.0228
0.35	0.3632	2.05	0.0202
0.40	0.3446	2.10	0.0179
0.45	0.3264	2.15	0.0158
0.50	0.3085	2.20	0.0139
0.55	0.2912	2.25	0.0122
0.60	0.2743	2.30	0.0107
0.65	0.2578	2.35	0.0094
0.70	0.2420	2.40	0.0082
0.75	0.2264	2.45	0.0071
0.80	0.2119	2.50	0.0062
0.85	0.1977	2.55	0.0054
0.90	0.1841	2.60	0.0047
0.95	0.1711	2.65	0.0040
1.00	0.1587	2.70	0.0035
1.05	0.1469	2.75	0.0030
1.10	0.1357	2.80	0.0026
1.15	0.1251	2.85	0.0022
1.20	0.1151	2.90	0.0019
1.25	0.1056	2.95	0.0016
1.30	0.0968	3.00	0.0013
1.35	0.0885	3.05	0.0011
1.40	0.0808	3.10	0.0010
1.45	0.0735	3.25	0.0006
1.50	0.0668	3.50	0.00023
1.55	0.0606	4.00	0.00003
1.60	0.0548	4.99	0.0000003
1.65	0.0495		

TABLE A.6

Value of Call Option as Percentage of Share Price

Share Price Divided by PV (*Exercise Price*)

Standard Deviation Times Square Root of Time	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.82	0.84	0.86	0.88	0.90	0.92	0.94	0.96	0.98	1.00
0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.6	1.2	2.0
0.10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.5	0.8	1.2	1.7	2.3	3.1	4.0
0.15	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.5	0.7	1.0	1.3	1.7	2.2	2.8	3.5	4.2	5.1	6.0
0.20	0.0	0.0	0.0	0.0	0.0	0.1	0.4	0.8	1.5	1.9	2.3	2.8	3.4	4.0	4.7	5.4	6.2	7.1	8.0
0.25	0.0	0.0	0.0	0.1	0.2	0.5	1.0	1.8	2.8	3.3	3.9	4.5	5.2	5.9	6.6	7.4	8.2	9.1	9.9
0.30	0.0	0.1	0.1	0.3	0.7	1.2	2.0	3.1	4.4	5.0	5.7	6.3	7.0	7.8	8.6	9.4	10.2	11.1	11.9
0.35	0.1	0.2	0.4	0.8	1.4	2.3	3.3	4.6	6.2	6.8	7.5	8.2	9.0	9.8	10.6	11.4	12.2	13.0	13.9
0.40	0.2	0.5	0.9	1.6	2.4	3.5	4.8	6.3	8.0	8.7	9.4	10.2	11.0	11.7	12.5	13.4	14.2	15.0	15.9
0.45	0.5	1.0	1.7	2.6	3.7	5.0	6.5	8.1	9.9	10.6	11.4	12.2	12.9	13.7	14.5	15.3	16.2	17.0	17.8
0.50	1.0	1.7	2.6	3.7	5.1	6.6	8.2	10.0	11.8	12.6	13.4	14.2	14.9	15.7	16.5	17.3	18.1	18.9	19.7
0.55	1.7	2.6	3.8	5.1	6.6	8.3	10.0	11.9	13.8	14.6	15.4	16.1	16.9	17.7	18.5	19.3	20.1	20.9	21.7
0.60	2.5	3.7	5.1	6.6	8.3	10.1	11.9	13.8	15.8	16.6	17.4	18.1	18.9	19.7	20.5	21.3	22.0	22.8	23.6
0.65	3.6	4.9	6.5	8.2	10.0	11.9	13.8	15.8	17.8	18.6	19.3	20.1	20.9	21.7	22.5	23.2	24.0	24.7	25.5
0.70	4.7	6.3	8.1	9.9	11.9	13.8	15.8	17.8	19.8	20.6	21.3	22.1	22.9	23.6	24.4	25.2	25.9	26.6	27.4
0.75	6.1	7.9	9.8	11.7	13.7	15.8	17.8	19.8	21.8	22.5	23.3	24.1	24.8	25.6	26.3	27.1	27.8	28.5	29.2
0.80	7.5	9.5	11.5	13.6	15.7	17.7	19.8	21.8	23.7	24.5	25.3	26.0	26.8	27.5	28.3	29.0	29.7	30.4	31.1
0.85	9.1	11.2	13.3	15.5	17.6	19.7	21.8	23.8	25.7	26.5	27.2	28.0	28.7	29.4	30.2	30.9	31.6	32.2	32.9
0.90	10.7	13.0	15.2	17.4	19.6	21.7	23.8	25.8	27.7	28.4	29.2	29.9	30.6	31.3	32.0	32.7	33.4	34.1	34.7
0.95	12.5	14.8	17.1	19.4	21.6	23.7	25.7	27.7	29.6	30.4	31.1	31.8	32.5	33.2	33.9	34.6	35.2	35.9	36.5
1.00	14.3	16.7	19.1	21.4	23.6	25.7	27.7	29.7	31.6	32.3	33.0	33.7	34.4	35.1	35.7	36.4	37.0	37.7	38.3
1.05	16.1	18.6	21.0	23.3	25.6	27.7	29.7	31.6	33.5	34.2	34.9	35.6	36.2	36.9	37.6	38.2	38.8	39.4	40.0
1.10	18.0	20.6	23.0	25.3	27.5	29.6	31.6	33.5	35.4	36.1	36.7	37.4	38.1	38.7	39.3	40.0	40.6	41.2	41.6
1.15	20.0	22.5	25.0	27.3	29.5	31.6	33.6	35.4	37.2	37.9	38.6	39.2	39.9	40.5	41.1	41.7	42.3	42.9	43.5
1.20	21.9	24.5	27.0	29.3	31.5	33.6	35.5	37.3	39.1	39.7	40.4	41.0	41.7	42.3	42.9	43.5	44.0	44.6	45.1
1.25	23.9	26.5	29.0	31.3	33.5	35.5	37.4	39.2	40.9	41.5	42.2	42.8	43.4	44.0	44.6	45.2	45.7	46.3	46.6

(Continued)

Share Price Divided by PV (*Exercise Price*)

Standard Deviation Times Square Root of Time

	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.82	0.84	0.86	0.88	0.90	0.92	0.94	0.96	0.98	1.00
1.30	25.9	28.5	31.0	33.3	35.4	37.4	39.3	41.0	42.7	43.3	43.9	44.5	45.1	45.7	46.3	46.8	47.4	47.9	48.4
1.35	27.9	30.5	33.0	35.2	37.3	39.3	41.1	42.8	44.4	45.1	45.7	46.3	46.8	47.4	47.9	48.5	49.0	49.5	50.0
1.40	29.9	32.5	34.9	37.1	39.2	41.1	42.9	44.6	46.2	46.8	47.4	47.9	48.5	49.0	49.6	50.1	50.6	51.1	51.6
1.45	31.9	34.5	36.9	39.1	41.1	43.0	44.7	46.4	47.9	48.5	49.0	49.6	50.1	50.7	51.2	51.7	52.2	52.7	53.2
1.50	33.8	36.4	38.8	40.9	42.9	44.8	46.5	48.1	49.6	50.1	50.7	51.2	51.8	52.3	52.8	53.3	53.7	54.2	54.7
1.55	35.8	38.4	40.7	42.8	44.8	46.6	48.2	49.8	51.2	51.8	52.3	52.8	53.3	53.8	54.3	54.8	55.3	55.7	56.2
1.60	37.8	40.3	42.6	44.6	46.5	48.3	49.9	51.4	52.8	53.4	53.9	54.4	54.9	55.4	55.9	56.3	56.8	57.2	57.6
1.65	39.7	42.2	44.4	46.4	48.3	50.0	51.6	53.1	54.4	54.9	55.4	55.9	56.4	56.9	57.3	57.8	58.2	58.6	59.1
1.70	41.6	44.0	46.2	48.2	50.0	51.7	53.2	54.7	56.0	56.5	57.0	57.5	57.9	58.4	58.8	59.2	59.7	60.1	60.5
1.75	43.5	45.9	48.0	50.0	51.7	53.4	54.8	56.2	57.5	58.0	58.5	58.9	59.4	59.8	60.2	60.7	61.1	61.5	61.8
2.00	52.5	54.6	56.5	58.2	59.7	61.1	62.4	63.6	64.6	65.0	65.4	65.8	66.2	66.6	66.9	67.3	67.6	67.9	68.3
2.25	60.7	62.5	64.1	65.6	66.8	68.0	69.1	70.0	70.9	71.3	71.6	71.9	72.2	72.5	72.8	73.1	73.4	73.7	73.9
2.50	67.9	69.4	70.8	72.0	73.1	74.0	74.9	75.7	76.4	76.7	77.0	77.2	77.5	77.7	78.0	78.2	78.4	78.7	78.9
2.75	74.2	75.4	76.6	77.5	78.4	79.2	79.9	80.5	81.1	81.4	81.6	81.8	82.0	82.2	82.4	82.6	82.7	82.9	83.1
3.00	79.5	80.5	81.4	82.2	82.9	83.5	84.1	84.6	85.1	85.3	85.4	85.6	85.8	85.9	86.1	86.2	86.4	86.5	86.6
3.50	87.6	88.3	88.8	89.3	89.7	90.1	90.5	90.8	91.1	91.2	91.3	91.4	91.5	91.6	91.6	91.7	91.8	91.9	92.0
4.00	92.9	93.3	93.6	93.9	94.2	94.4	94.6	94.8	94.9	95.0	95.0	95.1	95.2	95.2	95.3	95.3	95.4	95.4	95.4
4.50	96.2	96.4	96.6	96.7	96.9	97.0	97.1	97.2	97.3	97.3	97.3	97.4	97.4	97.4	97.5	97.5	97.5	97.5	97.6
5.00	98.1	98.2	98.3	98.3	98.4	98.5	98.5	98.6	98.6	98.6	98.6	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.8

Share Price Divided by PV (*Exercise Price*)

	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.16	1.18	1.20	1.25	1.30	1.35	1.40	1.45	1.50	1.75	2.00	2.50
0.05	3.1	4.5	6.0	7.5	9.1	10.7	12.3	13.8	15.3	16.7	20.0	23.1	25.9	28.6	31.0	33.3	42.9	50.0	60.0
0.10	5.0	6.1	7.3	8.6	10.0	11.3	12.7	14.1	15.4	16.8	20.0	23.1	25.9	28.6	31.0	33.3	42.9	50.0	60.0
0.15	7.0	8.0	9.1	10.2	11.4	12.6	13.8	15.0	16.2	17.4	20.4	23.3	26.0	28.6	31.1	33.3	42.9	50.0	60.0
0.20	8.9	9.9	10.9	11.9	13.0	14.1	15.2	16.3	17.4	18.5	21.2	23.9	26.4	28.9	31.2	33.5	42.9	50.0	60.0
0.25	10.9	11.8	12.8	13.7	14.7	15.7	16.7	17.7	18.7	19.8	22.3	24.7	27.1	29.4	31.7	33.8	42.9	50.0	60.0
0.30	12.8	13.7	14.6	15.6	16.5	17.4	18.4	19.3	20.3	21.2	23.5	25.8	28.1	30.2	32.3	34.3	43.1	50.1	60.0
0.35	14.8	15.6	16.5	17.4	18.3	19.2	20.1	21.0	21.9	22.7	24.9	27.1	29.2	31.2	33.2	35.1	43.5	50.2	60.0
0.40	16.7	17.5	18.4	19.2	20.1	20.9	21.8	22.6	23.5	24.3	26.4	28.4	30.4	32.3	34.2	36.0	44.0	50.5	60.1
0.45	18.6	19.4	20.3	21.1	21.9	22.7	23.5	24.3	25.1	25.9	27.9	29.8	31.7	33.5	35.3	37.0	44.6	50.8	60.2
0.50	20.5	21.3	22.1	22.9	23.7	24.5	25.3	26.1	26.8	27.6	29.5	31.3	33.1	34.8	36.4	38.1	45.3	51.3	60.4
0.55	22.4	23.2	24.0	24.8	25.5	26.3	27.0	27.8	28.5	29.2	31.0	32.8	34.5	36.1	37.7	39.2	46.1	51.9	60.7
0.60	24.3	25.1	25.8	26.6	27.3	28.1	28.8	29.5	30.2	30.9	32.6	34.3	35.9	37.5	39.0	40.4	47.0	52.5	61.0
0.65	26.2	27.0	27.7	28.4	29.1	29.8	30.5	31.2	31.9	32.6	34.2	35.8	37.4	38.9	40.3	41.7	48.0	53.3	61.4
0.70	28.1	28.8	29.5	30.2	30.9	31.6	32.3	32.9	33.6	34.2	35.8	37.3	38.8	40.3	41.6	43.0	49.0	54.0	61.9
0.75	29.9	30.6	31.3	32.0	32.7	33.3	34.0	34.6	35.3	35.9	37.4	38.9	40.3	41.7	43.0	44.3	50.0	54.9	62.4
0.80	31.8	32.4	33.1	33.8	34.4	35.1	35.7	36.3	36.9	37.5	39.0	40.4	41.8	43.1	44.4	45.6	51.1	55.8	63.0
0.85	33.6	34.2	34.9	35.5	36.2	36.8	37.4	38.0	38.6	39.2	40.6	41.9	43.3	44.5	45.8	46.9	52.2	56.7	63.6
0.90	35.4	36.0	36.6	37.3	37.9	38.5	39.1	39.6	40.2	40.8	42.1	43.5	44.7	46.0	47.1	48.3	53.3	57.6	64.3
0.95	37.2	37.8	38.4	39.0	39.6	40.1	40.7	41.3	41.8	42.4	43.7	45.0	46.2	47.4	48.5	49.6	54.5	58.6	65.0
1.00	38.9	39.5	40.1	40.7	41.2	41.8	42.4	42.9	43.4	44.0	45.2	46.5	47.6	48.8	49.9	50.9	55.6	59.5	65.7
1.05	40.6	41.2	41.8	42.4	42.9	43.5	44.0	44.5	45.0	45.5	46.8	48.0	49.1	50.2	51.2	52.2	56.7	60.5	66.5
1.10	42.3	42.9	43.5	44.0	44.5	45.1	45.6	46.1	46.6	47.1	48.3	49.4	50.5	51.6	52.6	53.5	57.9	61.5	67.2
1.15	44.0	44.6	45.1	45.6	46.2	46.7	47.2	47.7	48.2	48.6	49.8	50.9	51.9	52.9	53.9	54.9	59.0	62.5	68.0
1.20	45.7	46.2	46.7	47.3	47.8	48.3	48.7	49.2	49.7	50.1	51.3	52.3	53.3	54.3	55.2	56.1	60.2	63.5	68.8
1.25	47.3	47.8	48.4	48.8	49.3	49.8	50.3	50.7	51.2	51.6	52.7	53.7	54.7	55.7	56.6	57.4	61.3	64.5	69.6

(Continued)

Share Price Divided by PV (*Exercise Price*)

Standard Deviation Times Square Root of Time

	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.16	1.18	1.20	1.25	1.30	1.35	1.40	1.45	1.50	1.75	2.00	2.50
1.30	48.9	49.4	49.9	50.4	50.9	51.3	51.8	52.2	52.7	53.1	54.1	55.1	56.1	57.0	57.9	58.7	62.4	65.5	70.4
1.35	50.5	51.0	51.5	52.0	52.4	52.9	53.3	53.7	54.1	54.6	55.6	56.5	57.4	58.3	59.1	59.9	63.5	66.5	71.1
1.40	52.1	52.6	53.0	53.5	53.9	54.3	54.8	55.2	55.6	56.0	56.9	57.9	58.7	59.6	60.4	61.2	64.6	67.5	71.9
1.45	53.6	54.1	54.5	55.0	55.4	55.8	56.2	56.6	57.0	57.4	58.3	59.2	60.0	60.9	61.6	62.4	65.7	68.4	72.7
1.50	55.1	55.6	56.0	56.4	56.8	57.2	57.6	58.0	58.4	58.8	59.7	60.5	61.3	62.1	62.9	63.6	66.8	69.4	73.5
1.55	56.6	57.0	57.4	57.8	58.2	58.6	59.0	59.4	59.7	60.1	61.0	61.8	62.6	63.3	64.1	64.7	67.8	70.3	74.3
1.60	58.0	58.5	58.9	59.2	59.6	60.0	60.4	60.7	61.1	61.4	62.3	63.1	63.8	64.5	65.2	65.9	68.8	71.3	75.1
1.65	59.5	59.9	60.2	60.6	61.0	61.4	61.7	62.1	62.4	62.7	63.5	64.3	65.0	65.7	66.4	67.0	69.9	72.2	75.9
1.70	60.9	61.2	61.6	62.0	62.3	62.7	63.0	63.4	63.7	64.0	64.8	65.5	66.2	66.9	67.5	68.2	70.9	73.1	76.6
1.75	62.2	62.6	62.9	63.3	63.6	64.0	64.3	64.6	64.9	65.3	66.0	66.7	67.4	68.0	68.7	69.2	71.9	74.0	77.4
2.00	68.6	68.9	69.2	69.5	69.8	70.0	70.3	70.6	70.8	71.1	71.7	72.3	72.9	73.4	73.9	74.4	76.5	78.3	81.0
2.25	74.2	74.4	74.7	74.9	75.2	75.4	75.6	75.8	76.0	76.3	76.8	77.2	77.7	78.1	78.5	78.9	80.6	82.1	84.3
2.50	79.1	79.3	79.5	79.7	79.9	80.0	80.2	80.4	80.6	80.7	81.1	81.5	81.9	82.2	82.6	82.9	84.3	85.4	87.2
2.75	83.3	83.4	83.6	83.7	83.9	84.0	84.2	84.3	84.4	84.6	84.9	85.2	85.5	85.8	86.0	86.3	87.4	88.3	89.7
3.00	86.8	86.9	87.0	87.1	87.3	87.4	87.5	87.6	87.7	87.8	88.1	88.3	88.5	88.8	89.0	89.2	90.0	90.7	91.8
3.50	92.1	92.1	92.2	92.3	92.4	92.4	92.5	92.6	92.6	92.7	92.8	93.0	93.1	93.3	93.4	93.5	94.0	94.4	95.1
4.00	95.5	95.5	95.6	95.6	95.7	95.7	95.7	95.8	95.8	95.8	95.9	96.0	96.1	96.2	96.2	96.3	96.6	96.8	97.2
4.50	97.6	97.6	97.6	97.6	97.7	97.7	97.7	97.7	97.8	97.8	97.8	97.9	97.9	97.9	98.0	98.0	98.2	98.3	98.5
5.00	98.8	98.8	98.8	98.8	98.8	98.8	98.8	98.8	98.9	98.9	98.9	98.9	98.9	99.0	99.0	99.0	99.1	99.1	99.2

APPENDIX B

Project Financing in India

Project financing refers to the means of finance employed for meeting the cost of project. In Chapter 6, we looked briefly at the means of finance available in India and the key considerations relevant in planning the capital structure for a new project. This appendix examines this issue in greater detail. It is organised as follows:

- Means of finance
- Norms and policies of financial institutions
- SEBI guidelines
- Sample financing plans

MEANS OF FINANCE

The long-term sources of finance used for meeting the cost of project are referred to as the means of finance. To meet the cost of project, the following sources of finance may be available:

- Equity capital
- Preference capital
- Non-convertible debentures
- Convertible debentures
- Rupee term loans
- Foreign currency term loans
- Euroissues
- Deferred credit
- Bill rediscounting scheme
- Suppliers line of credit
- Seed capital assistance
- Government subsidies
- Sales tax deferment and exemption
- Unsecured loans and deposits
- Lease and hire purchase finance

Equity Capital

This is the contribution made by the owners of business, the equity shareholders, who enjoy the rewards and bear the risks of ownership. However, their liability is limited to their capital contribution. From the point of view of the issuing firm, equity capital offers two important advantages: (i) It represents permanent capital. Hence there is no liability for repayment. (ii) It does not involve any fixed obligation for payment of dividends. The disadvantages of raising funds by way of equity capital are : (i) The cost of equity capital is high because equity dividends are not tax-deductible expenses. (ii) The cost of issuing equity capital is high.

Preference Capital

A hybrid form of financing, preference capital partakes some characteristics of equity capital and some attributes of debt capital. It is similar to equity capital because preference dividend, like equity dividend, is not a tax-deductible payment. It resembles debt capital because the rate of preference dividend is fixed. Typically, when preference dividend is skipped it is payable in future because of the cumulative feature associated with it. The near-fixity of preference dividend payment renders preference capital somewhat unattractive in general as a source of finance. It is, however, attractive when the promoters do not want a reduction in their share of equity and yet there is need for widening the net worth base (net worth consists of equity and preference capital) to satisfy the requirements of financial institutions. In addition to the conventional preference shares, a company may issue Cumulative Convertible Preference Shares (CCPS). These shares carry a dividend rate of 10 per cent (which, if unpaid, cumulates) and are compulsorily convertible into equity shares between three and five years from the date of issue.

Debenture Capital

In the last few years, debenture capital has emerged as an important source for project financing. There are three types of debentures that are commonly used in India: Non-Convertible Debentures (NCDs), Partially Convertible Debentures (PCDs), and Fully Convertible Debentures (FCDs). Akin to promissory, NCDs are used by companies for raising debt that is generally retired over a period of 5 to 10 years. They are secured by a charge on the assets of the issuing company. PCDs are partly convertible into equity shares as per pre-determined terms of conversion. The unconverted portion of PCDs remains like NCD. FCDs, as the name implies, are converted wholly into equity shares as per pre-determined terms of conversion. Hence FCDs may be regarded as delayed equity instruments.

Rupee Term Loans

Provided by financial institutions and commercial banks, rupee term loans which represent secured borrowings are a very important source for financing new projects as well as expansion, modernisation, and renovation schemes of existing units. These loans are generally repayable over a period of 8-10 years which includes a moratorium period of 1-3 years.

Foreign Currency Terms Loans

Financial institutions provide foreign currency term loans for meeting the foreign currency expenditures towards import of plant, machinery, and equipment and also towards payment of foreign technical know-how fees. Under the general scheme, the periodical liability towards interest and principal remains in the currency/currencies of the loan/s and is translated into rupees at the then prevailing rate of exchange for making payments to the financial institution. Apart from approaching financial institutions (which typically serve as intermediaries between foreign agencies and Indian borrowers), companies can directly obtain foreign currency loans from international lenders. More and more companies appear to be doing so presently.

Euroissues

Beginning with Reliance Industries' Global Depository Receipts issue of approximately $150 ml in May 1992, a number of companies have been making euroissues. They have employed two types of securities: Global Depository Receipts (GDRs) and Euroconvertible Bonds (ECBs).

Denominated in US dollars, a GDR is a negotiable certificate that represents the publicly traded local currency (Indian Rupee) equity shares of a non-US (Indian) company. (Of course, in theory, a GDR may represent a debt security; in practice it rarely does so.) GDRs are issued by the Depository Bank (such as the Bank of New York) against the local currency shares (such as Rupee shares) which are delivered to the depository's local custodian banks. GDRs trade freely in the overseas markets.

A Euroconvertible Bond (ECB) is an equity-linked debt security. The holder of an ECB has the option to convert it into equity shares at a pre-determined conversion ratio during a specified period. ECBs are regarded as advantageous by the issuing company because (i) they carry a lower rate of interest compared to a straight debt security, (ii) they do not lead to dilution of earnings per share in the near future, and (iii) they carry very few restrictive covenants.

Deferred Credit

Many a time the suppliers of machinery provide deferred credit facility under which payment for the purchase of machinery is made over a period of time. The interest rate on deferred credit and the period of payment vary rather widely. Normally, the supplier of machinery when he offers deferred credit facility insists that the bank guarantee should be furnished by the buyer.

Bills Rediscounting Scheme

Operated by the IDBI, the bills rediscounting scheme is meant to promote the sale of indigenous machinery on deferred payment basis. Under this scheme, the seller realises the sale proceeds by discounting the bills or promissory notes accepted by the buyer with a commercial bank which in turn rediscounts them with the IDBI. This scheme is meant primarily for balancing equipments and equipments and machinery required for expansion, modernisation, and replacement schemes.

Suppliers' Line of Credit

Administered by the ICICI, the Suppliers' Line of Credit is somewhat similar to the IDBI's Bill Rediscounting Scheme. Under this arrangement, ICICI directly pays to the machinery manufacturer against usance bills duly accepted or guaranteed by the bank of the purchaser.

Seed Capital Assistance

Financial institutions, through what may be labelled broadly as the 'Seed Capital Assistance scheme, seek to supplement the resources of the promoters of the small and medium scale industrial units which are eligible for assistance from all-India financial institutions and/or state-level financial institutions. Broadly three schemes have been formulated:

(i) *Special Seed Capital Assistance Scheme* The quantum of assistance under this scheme is Rs 0.2 million or 20 per cent of the project cost, whichever is lower. This scheme is administered by the State Financial Corporations.

(ii) *Seed Capital Assistance Scheme* The assistance under this scheme is applicable to projects costing not more than Rs 20 million. The assistance per project is restricted to Rs 1.5 million. The assistance is provided by IDBI through state level financial institutions. In special cases, the IDBI may provide the assistance directly.

(iii) *Risk Capital Foundation Scheme* Under this scheme, the Risk Capital Foundation, an autonomous foundation set up and funded by the IFCI, offers assistance to promoters of projects costing between Rs 20 million and Rs 150 million. The ceiling on the assistance provided between Rs 1.5 million and Rs 4 million depending on the number of applicant promoters.

Government Subsidies

Previously the central government as well as the state governments provided subsidies to industrial units located in backward areas. The central subsidy has been discontinued but the state subsidies continue. The state subsidies vary between 5 per cent to 25 per cent of the fixed capital investment in the project, subject to a ceiling varying between Rs 0.5 million and Rs 2.5 million depending on the location.

Sales Tax Deferments and Exemptions

To attract industries, the states provide incentives, *inter alia*, in the form of sales tax deferments and sales tax exemptions.

Under the sales tax deferment scheme, the payment of sales tax on the sale of finished goods may be deferred for a period ranging between five to twelve years. Essentially it implies that the project gets an interest-free loan, represented by the quantum of sales tax deferred, during the deferment period.

Under the sales tax exemption scheme, some states exempt the payment of sales tax applicable on purchases of raw materials, consumables, packing, and processing materials from within the state which are used for manufacturing purposes. The period of exemption ranges from three to nine years depending upon the state and the specific location of the project within the state.

Unsecured Loans and Deposits

Unsecured loans are typically provided by the promoters to fill the gap between the promoters' contribution required by financial institutions and the equity capital subscribed to by the promoters. These loans are subsidiary to the institutional loans. The rate of interest chargeable on these loans is less than the rate of interest on the institutional loans. Finally these loans cannot be taken back without the prior approval of financial institutions.

Deposits from public, referred to as public deposits, represent unsecured borrowing of two to three years' duration. Many existing companies prefer to raise public deposits instead of term loans from financial institutions because restrictive covenants do not accompany public deposits. However, it may not be possible for a new company to raise public deposits. Further, it may be difficult for it to repay public deposits within three years.

Leasing and Hire Purchase Finance

With the emergence of scores of finance companies engaged in the business of leasing and hire purchase finance, it may be possible to get a portion, albeit a small portion, of the assets financed under a lease or a hire purchase arrangement.

Typically, a project is financed partly by financial institutions and partly through the resources raised from the capital market. Hence, in finalising the financing scheme for a project, you should bear in mind the norms and policies of financial institutions and the guidelines of Securities Exchange Board of India and the requirements of the Securities Contracts Regulation Act (SCRA).

NORMS AND POLICIES OF FINANCIAL INSTITUTIONS

The principal norms and policies of financial institutions are described below:

Eligibility

Till recently, long term loans were provided by financial institutions to concerns in certain industries and denied to concerns in industries placed in the negative list. Now, however, a shift is taking place in their policy. They are inclined to finance almost every kind of industry. Further, till recently financial institutions followed a consortium approach as per the advice of the Ministry of Finance. Now they are permitted to lend individually as well as participate in consortium lending.

Debt-equity Ratio

Presently, the general debt-equity norm for medium and large scale projects is 1.5:1. This serves as a broad guideline against which variations are permitted on a case to case basis, especially under the following circumstances: (a) high degree of capital intensity, (b) location in a backward area, and (c) background of the promoter. Other things being equal: (i) a capital intensive project is eligible for a higher debt-equity ratio, (ii) a project in a backward area qualifies for a higher debt-equity ratio, and (iii) a project promoted by a technocrat—promoter is entitled to a higher debt-equity ratio.

How are debt and equity defined for the purpose of calculating the debt-equity ratio? *Debt* consists of the following: (i) loans and deposits that are repayable after one year (this includes interest bearing unsecured loans from government agencies, promoters, etc.), (ii) non-convertible debentures and convertible debentures (except that part which is compulsorily convertible into equity) until they are converted, irrespective of the maturity period, (iii) deferred payments, and (iv) preference shares due for redemption within three years.

Equity consists of the following: (i) paid-up ordinary share capital, (ii) irredeemable preference shares, cumulative convertible preference shares where the redemption period is due after three years, (iii) premium on share issues, (iv) central/state cash subsidy, (v) long term interest-free unsecured loans from state governments or government agencies or promoters subordinate to loan from financial institutions, and (vi) free reserves (including surplus in profit and loss account) less any accumulated losses, arrears or unabsorbed depreciation, intangible assets (like goodwill), expenditures not written off (like preliminary expenses), and investments in other undertakings where these are 'prima facie' considered unrealisable.

Promoters' Contribution

Financial institutions require promoters to contribute 25 to 30 per cent of the project cost. This is lowered selectively in certain cases like capital-intensive projects, high priority projects, and technocrat-promoted projects. Contributions made by the following or of the following kinds represent promoters' contribution (i) equity investment by promoters, their friends, relatives and associates (including NRIs), (ii) equity investment by other companies controlled by promoters, (iii) equity participation by shareholders of other promoter companies, (iv) foreign collaborators, (v) investment from oil exporting developing countries, (vi) state government, in the case of joint sector or assisted sector projects, (vii) seed capital assistance, (viii) unsecured loan from promoters, (ix) venture capital participation, (x) mutual fund participation, (xi) internal accruals in the case of an existing company, (xii) rights issue to existing shareholders, and (xiii) any other contribution approved as promoters' contribution.

Foreign Currency Loans

Apart from rupee term loans, financial institutions provide foreign currency loans. This assistance is now provided only for the import of capital equipment (as per the liberalised exchange risk management system, foreign currency required for other purposes has to be purchased from authorised dealers at market rates). On foreign currency loans sanctioned under the general scheme, the interest rate charged is typically a floating rate as determined by the lenders (the foreign agency that has given a line of credit to the financial institution for onward lending) and the risk of exchange rate fluctuation is borne by the borrower. On foreign currency loans sanctioned under the Exchange Risk Administration Scheme, the principal repayment obligations of the borrower are rupee tied at the rate of exchange prevailing on the dates of disbursement. On such rupee-tied loan liability, the borrower pays by way of servicing his loan a composite cost every quarter. The composite cost consists of three elements: (i) the interest portion which is arrived at on the basis of the weighted average interest cost of the various components of the currency pool, (ii) the spread of the financial institutions, and (iii) the exchange risk premium. The 'composite cost' is a variable rate determined at six-monthly intervals. It has a floor and a cap. Both the floor and the cap as well as the rate of interest applicable for the period is reviewed and announced from time to time.

SEBI GUIDELINES

The Capital Issues Control Act, 1947 (and the exemption orders and rules made thereunder) was the primary legislation regulating the issue of securities by the corporate sector till recently. This Act was repealed in May 1992 and capital issues were brought under the purview of the Securities Exchange Board of India (SEBI hereafter) which was clothed with statutory powers when the SEBI Act, 1992 was passed.

On June 12, 1992, SEBI released its guidelines applicable to capital issues. A comparison of these guidelines with the guidelines that were followed under the earlier regime (that is under the Capital Issues Control Act, 1947) suggests that the thrust of regulation is no longer on product and price control. In the earlier regime, there were restrictions on the kinds of securities that could be issued, the pricing of these securities, and the interest rates or dividend rates payable on them. Under the new regime there is virtually no restriction on the types of securities (financial instruments) that can be issued, there is substantial freedom in pricing these securities, and there is no ceiling on interest/dividend rate payable on these securities. While the new regime more or less does away with product and price controls, it lays stress on adequate disclosure, seeks to safeguard the interest of investors, and emphasises prudential controls. The key SEBI guidelines are summarised below.

New Instruments

While there is no restriction on the kinds of financial instruments, the issuer of capital shall make adequate disclosures regarding the terms and conditions, redemption, security, conversion, and any other features of the instrument so that an investor can make a reasonable determination of risks, returns, safety, and liquidity of the instruments. The disclosures shall be vetted by SEBI in this regard.

Pricing of Public Issues of Equity Capital

The salient features of SEBI guidelines with respect to the pricing of public issues of equity capital are as follows:

- A new company set up by entrepreneurs without a track record will be permitted to issue capital to public only at par.
- A new company set up by existing companies with a five year track record of consistent profitability will be free to price its issue provided the participation of the promoting companies is not less than 50 per cent of the equity of the new company and the issue price is made applicable to all new investors uniformly.
- An existing private/closely held company with a three year track record of consistent profitability shall be permitted to freely price the issue.
- An existing listed company can raise fresh capital by freely pricing further issue.

Fully Convertible Debentures (FCDs)/Partially Convertible Debentures (PCDs)/Non-convertible Debentures (NCDs)

The guidelines relevant to these instruments are as follows:

1. Credit rating is compulsory in the case of FCDs if the conversion is effected after 18 months and in the case of NCDs/PCDs if the maturity period exceeds 18 months.

2. In the case of FCDs/PCDs the terms of conversion (time of conversion and conversion price) shall be predetermined and stated in the prospectus.
3. Any conversion in part or whole of the debenture will be optional at the hands of the debenture holder, if the conversion takes place at or after 18 months from the date of allotment, but before 36 months. FCDs having a conversion period exceeding 36 months must have 'put' and 'call' option (the 'put' option gives the debenture holder the right to sell the debentures back to the company at a specified price whereas the 'call' option gives the company the right to buy back the debentures at a specified price).
4. A Debenture Redemption Reserve (DRR) shall be created by all companies raising debentures, except when the debenture issue has a maturity of 18 months or less, on the following basis: (a) A moratorium up to the date of commercial production can be provided for creation of the DRR in respect of debentures raised for project finance. (b) The DRR may be created either in equal instalments for the remaining period or higher amounts if profits permit. (c) In the case of PCDs, the DRR should be created in respect of the non-convertible portion of the debenture issue on the same lines as applicable to NCDs. In respect of convertible issues by new companies, the creation of the DRR should commence from the year the company earns profits for the remaining life of debentures. (d) Companies may distribute dividends out of general reserves in certain years if residual profits after transfer to the DRR are inadequate to distribute reasonable dividends. (e) The DRR will be treated as a part of general reserve for consideration of bonus issue proposals and for price fixation related to post-tax return. (f) In the case of new companies, distribution of dividend shall require approval of the trustees to the issue and the lead institution, if any. (g) The company should create the DRR equivalent to 50 per cent of the amount of debenture issue before the debenture redemption commences. Drawal from the DRR is permissible only after 10 per cent of the debenture liability has been actually redeemed by the company.

Promoters' Contribution and Lock-in Period

The key provisions in this regard are as follows: (a) Equity capital to be subscribed in any issue to the public by promoters, i.e., those described in the prospectus as promoters, directors, friends, relatives and associates should not be less than 25 per cent of the total issue of equity capital up to Rs 1000 million and 20 per cent of the issue above Rs 1000 million. In the case of FCDs, one third of issue amount should be contributed by promoters, directors, friends, relatives and associates by way of equity before the issue is made. In the case of PCDs, one third of the convertible portion should be brought in as contribution of promoters, directors, friends, relatives and associates before the issue is made. The minimum subscription by each of the friends/relatives and associates under the promoters' quota should not be less than Rs 0.1 million. (b) The promoters' contribution shall not be diluted for a lock-in period of five years from the date of commencement of the production or date of allotment whichever is later. Promoters must bring in their full subscription to issues in advance before public issue. (c) All firm allotments, preferential allotments to collaborators, shareholders of promoter companies, whether corporate or individual, shall not be transferable for three years from the date of the commencement of production or date of allotment whichever is later.

SAMPLE FINANCING PLANS

Four sample financing plans follow:

STI Granite India Limited

The project cost and means of finance for a project of STI Granite India Limited for the manufacture of 155,000 sq. mts. of granite and slabs that was appraised by SBI Capital Markets Limited in the month of May 1992 are given below:

Project Cost

		Rs in million
– Land and Site Development		12.1
– Buildings		16.6
– Plant and Machinery		
Imported	142.7	
Indigenous	2.5	
Foundation	5.0	
		150.2
– Training Expenses		0.2
– Miscellaneous Fixed Assets		26.2
– Preliminary and Capital Issue Expenses		7.9
– Preoperative Expenses		13.3
– Provision for Contingencies		21.7
– Margin for Working Capital		11.9
		260.1

Means of Finance

		Rs in million
– Equity Share Capital		
Promoters	38.7	
UTI	5.0	
EEC	15.0	
Public (Convertible portion of debentures)	40.0	
		98.7
– Debt		
Non-convertible portion of debentures	40.0	
Foreign Exchange Loan	117.8	
		157.8
– Capital Subsidy		2.0
– Lease Finance		1.6
		260.1

Rana Sugars Limited

The project cost and the means of finance for a project of Rana Sugars Limited for the manufacture of white crystal sugar and co-generation of power to the extent of 5W, which was reappraised in March 1993 by the Industrial Finance Corporation of India, are given below:

Project Cost

	Rs in million
– Land and Site Development	13.25
– Buildings and Civil Works	52.57
– Plant and Machinery	235.38
– Miscellaneous Fixed Assets	14.10
– Preliminary and Preoperative Expenses	61.20
– Cane Development Expenses	3.00
– Margin Money for Working Capital	7.50
– Provision for Contingency	1.00
	388.00

Means of Finance

		Rs in million
– Share Capital		
Punjab Agro Industries Corporation	61.00	
Private Promoters	36.50	
Public Issue	108.00	
		205.50
– State Subsidy		5.00
– Term Loans		
Institutions	170.00	
State Bank of India	5.00	
State Bank of Patiala	2.50	
		177.50
		388.00

Zee Telefilms Limited

Zee Telefilms Limited came with an equity issue in 1993 for financing a project for setting up a studio and software facilities and meeting certain other expenses. The cost of project and means of finance were as follows:

Project Cost

	Rs in million
– Land and Buildings	33.1
– Equipments	38.9
– Miscellaneous Fixed Assets	7.0
– Software Production, Procurement and Commissioning	190.2
– Preliminary and Preoperative Expenses	20.2
– Margin Money for Working Capital	58.0
– Provision for Contingencies	120.0
Total	359.2

Means of Finance

	Rs in million
– Rights Issue of Equity Shares	89.2
– Public Issue of Equity Shares	270.0
Total	359.2

Reliance Petroleum Limited

The estimated cost of project and means of finance for a 9 million metric tonnes per annum fuel refinery project of Reliance Petroleum, as appraised by IDBI in April 1993, are given below:

Project Cost

	Rs in million
– Land and Site Development	920
– Building and Township	880
– Plant and Machinery	28870
– Technical Know-how/Detailed Engineering and Training Expenses	1090
– Miscellaneous Fixed Assets	2620
– Preliminary and Pre-operative Expenses	5030
– Contingency Provision	9850
– Margin Money for Working Capital	2160
Total	51420

Means of Finance

	Rs in million
– Privately Placed PCDs with 20% Optional Conversion at Par	10000
– Overseas Suppliers Credit/ECB/ Other Credits	6000
– Reliance Industries Limited and Associates	
TOCDs[1]	5770
Leasing/Unsecured Loans	1430
– Leasing by Other Companies/Unsecured Loans	3500
– Euro Issue/FIIs/Collaborators/Multi-lateral Agencies/NRIs/OCB's/Other Investors	3000
– Public Issue of TOCDs and Warrants	21720
Total	51420

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[1] Triple Option Convertible Debentures

APPENDIX C

Financial Institutions

Since independence, a number of financial institutions, some operating on an all-India basis and others functioning within their respective states, have been established. They have been reasonably responsive to the growing and varied long-term capital requirements of industry. They provide the bulk of long-term industrial finance, lay emphasis on development of backward regions, encourage competent new entrepreneurs, support modernisation efforts, and engage in promotional activities.

This appendix, concerned with the various aspects of financial institutions and their functioning in India, is divided into six sections as follows:

- Institutional structure
- Financial assistance: direct and indirect
- Special schemes
- Term loan procedures
- Project appraisal
- Key financial indicators

INSTITUTIONAL STRUCTURE

The structure of financial institutions in India is as follows:

I. All India institutions
  - Industrial Finance Corporation of India
  - Industrial Credit and Investment Corporation of India
  - Industrial Development Bank of India
  - Other all-India institutions

II. State-level institutions
  - State Financial Corporations
  - State Industrial Development Corporations

Industrial Finance Corporation of India The Industrial Finance Corporation of India (IFCI, hereafter), the first all-India term-lending institution, was set up in 1948 with the primary objective of providing medium and long-term credit to industry. It is headquartered in New Delhi. The source of funds for IFCI are paid-up capital, reserves, repayment of loans, market borrowing, loans from the Government of India, advances from the Industrial Development

Bank of India, and foreign lines of credit from KfW (West Germany), FFCE (France), ODA (UK), and others.

Industrial Credit and Investment Corporation of India The Industrial Credit and Investment Corporation of India (ICICI, hereafter) was founded in 1955. It is owned and financed mainly by the private sector. It is headquartered in Bombay. It provides assistance to units in the private sector, particularly to meet their foreign exchange requirements. The resources of ICICI consist of paid-up capital, reserves, repayment of loans, borrowing from the Government of India, advances from the Industrial Bank of India, market borrowings, and foreign lines of credit from the World Bank, USAID, KfW, UK Government and others.

Industrial Development Bank of India . The Industrial Development Bank of India (IDBI, hereafter) was established in 1964 as a subsidiary of the Reserve Bank of India. It is headquartered in Bombay. It is the apex term-lending financial institution in India. It has been designated as the principal financial institution of the country for coordinating, in conformity with national priorities, the working of institutions engaged in financing, promoting, and developing industry. IDBI finances the industry directly and also provides principal support to State Financial Corporations and State Industrial Development Corporations and commercial banks in their financing of industries, through refinancing and bill discounting facilities. The resources of IDBI consist of paid-up capital, reserves, repayment of loans, market borrowings both within and outside the country, temporary credit from the Reserve Bank of India, and foreign lines of credit from the World Bank, Asian Development Bank and others.

Life Insurance Corporation of India The Life Insurance Corporation of India (LIC, hereafter) came into being in 1956 after the nationalisation and merger of about 250 independent life insurance societies. It is headquartered in Bombay. The primary activity of LIC is to conduct the life insurance business, but it has gradually developed into an important all-India financial institution which provides substantial support to industry. It works in close liaison with the other all-India financial institutions in providing finance directly and in helping industrial concerns by its underwriting support. Thanks to its massive resources, LIC is one of the two largest institutional investors in the country. By law it is required to invest 25 per cent of its funds in government securities and a further 25 per cent in 'approved securities'.

General Insurance Corporation The General Insurance Corporation (GIC, hereafter) was founded when the management of general insurance business in India was taken over by the government in 1971 and subsequently nationalised in 1973. It is headquartered in Bombay. In addition to investing in 'socially-oriented' sectors, where the bulk of its investable resources are required to be invested, GIC provides substantial assistance to industrial projects by way of term loans, subscription to equity capital and debentures, and underwriting of securities.

Unit Trust of India The Unit Trust of India (UTI, hereafter) was set up in 1964 with the principal objective of mobilising public savings and channelling them into productive corporate investments. UTI raises its resources primarily through the sale of small denomination units. UTI subscribes to industrial securities and also purchases outstanding securities in the secondary market. In its investment activity, UTI is naturally governed by considerations of yield and security as it has an obligation to earn a reasonable rate of return for its unit holders in its various schemes, without exposing them to undue risks. UTI has emerged as one of the two largest institutional investors in India.

Industrial Reconstruction Bank of India The Industrial Reconstruction Bank of India (IRBI, hereafter), headquartered in Calcutta, was set up when its precursor, the Industrial Reconstruction Corporation of India, was reconstituted in 1984. IRBI is primarily an agency to help the reconstruction and rehabilitation of industrial units which have closed down or which face the risk of closure. IRBI offers assistance in various forms: (i) financial assistance which is not available from normal channels of finance and banking, (ii) technical assistance and guidance to sick units to revive them, (iii) managerial assistance in the fields of administration, finance, marketing, industrial relations, etc. and (iv) suggestions for reconstruction and rationalisation. IRBI's resources consist of its paid up capital, interest-free loan from the Government of India, and debt capital raised by issuing bonds. In addition, IRBI has recourse to accommodation from the Reserve Bank of India and IDBI.

State Level Institutions

State Financial Corporations The State Financial Corporations (SFCs, hereafter), set up under the State Financial Corporations Act, 1951, render assistance to medium and small scale industries in their respective states. Their shareholders are the respective state governments, IDBI, insurance companies, credit cooperatives and private shareholders. The financial resources of SFCs consist of paid-up capital, reserves, market borrowings, refinance from IDBI, and borrowings from the Reserve Bank of India and the Government of India.

State Industrial and Development Corporations The State Industrial Development Corporations, (SIDCs, hereafter) were set up by the state governments during the 1960s to serve as catalytic agents in the industrialisation process of their respective states. Presently almost every state has an SIDC which is fully owned by the respective state government. In addition to providing term finance to industry, SIDCs perform a variety of other functions. In particular, the role in sponsoring joint sector projects with the participation of private entrepreneur, needs to be emphasised. The major resources of the SIDCs are paid-up capital, reserves, market borrowings and loans from the government. In addition, SIDCs get funds from IDBI under its refinancing scheme.

FINANCIAL ASSISTANCE: DIRECT AND INDIRECT

Direct Financial Assistance

Financial institutions provide direct financial assistance in the following ways:

- Rupee term loans
- Foreign currency term loans
- Subscription to equity shares
- Seed capital

Rupee Term Loans The most significant form of assistance provided by financial institutions, rupee term loans are given directly to industrial concerns for setting up new projects as well as for expansion, modernisation, and renovation projects. These funds are provided for incurring expenditure toward land, building, plant and machinery, technical know-how, miscellaneous fixed assets, preliminary expenses, preoperative expenses, and margin money for working capital.

Foreign Currency Term Loans Financial institutions provide foreign currency term loans for meeting the foreign currency expenditures towards import of plant, machinery and equipment, and also towards payment of foreign technical know-how fees. The periodical liability for interest and principal remains in the currency/currencies of the loans and is translated into rupees at the then prevailing rate of exchange for making payments to the financial institutions. The borrower has the option of the Exchange Risk Administration Scheme also.

Direct Subscription to Equity In addition to providing term loans (in rupees as well as foreign currencies), financial institutions also subscribe to equity capital, albeit in a limited way.

Seed Capital Financial institutions, through what may be labelled broadly as the Seed Capital Assistance, seek to supplement the resources of the promoters of the small and medium scale industrial units which are eligible for assistance from all-India financial institutions and/or state-level financial institutions. Broadly, three schemes have been formulated:

- *Special Seed Capital Assistance Scheme* The quantum of assistance under this scheme is Rs 0.2 million or 20 per cent of the project cost, whichever is lower. This scheme is administered by the State Financial Corporations.
- *Seed Capital Assistance Scheme* The assistance under this scheme is restricted to Rs 1.5 million. This scheme is applicable to projects costing not more than Rs 20 million. The assistance per project is restricted to Rs. 1.5 million. The assistance is provided by IDBI through state level financial institutions. In special cases, IDBI may provide the assistance directly.
- *Risk Capital Foundation Scheme* Under this scheme, the Risk Capital Foundation, an autonomous foundation set up and funded by IFCI, offers assistance to promoters of projects costing between Rs 20 million and Rs 150 million. The ceiling on the assistance provided varies between Rs 1.5 million and Rs 4 million depending on the number of applicant promoters.

Indirect Financial Assistance

Besides providing direct financial assistance, financial institutions extend help to industrial units in obtaining finance/credit through the following ways:

- Deferred payment guarantee
- Guarantee for foreign currency loans
- Underwriting

Deferred Payment Guarantee Financial institutions issue guarantee on behalf of the buyer of industrial machinery to the supplier offering the facility of deferred payments. Should there be a default by the buyer in the payment of deferred instalments, financial institutions make the payment and subsequently recover the amount from the assisted unit. A nominal commission is charged for providing such guarantee.

Guarantee for Foreign Currency Loans Financial institutions provide guarantee for foreign currency loans obtained by industrial concerns from institutions and banks abroad. A nominal commission is charged to the assisted unit for such guarantee.

Underwriting As part of the overall financial package, financial institutions generally participate in underwriting equity issues of assisted units. This helps the assisted units in raising funds from the capital market.

SPECIAL SCHEMES

Several special schemes have been designed to serve the varied needs of industry. The important ones are:

- Bill rediscounting scheme
- Suppliers' line of credit
- Soft loan scheme
- Equipment finance scheme

Bill Rediscounting Scheme

IDBI has a bill rediscounting scheme to enable industrial units to buy capital equipment on a deferred payment basis. This scheme works as follows:

- The prospective buyer suggests to the manufacturer/seller of capital equipment, that instead of making full payment in cash he would like to avail of the facility of deferred payments under the bill rediscounting scheme IDBI.
- The manufacturer/seller, if he agrees to the proposal of the buyer, divides the cost of equipment, excluding advance payment, into half-yearly or yearly instalments and prepares a separate bill/promissory note for each instalment plus interest in respect of deferred payments. (The period of deferred payment is normally not more that 5 years.)
- The bills/promissory notes are accepted/guaranteed by, or on behalf of the buyer, on delivery of the equipment.
- The manufacturer/seller discounts the bills/promissory notes with his banker, realising the cost of his machinery. (The discount payable by the seller/manufacturer to his banker is included in the amount of bills in the form of interest.)
- The banker of the manufacturer/seller rediscounts the bills with IDBI, under the bill rediscounting scheme, thus obtaining the amount paid to the manufacturer/seller.
- The banker of the manufacturer/seller buys back the bills from IDBI three days (working days) in advance of their due dates and gets payments from the acceptor/guarantor of the bills on maturity due dates.

Suppliers Line of Credit

Somewhat similar to the bill rediscounting scheme of IDBI, the suppliers line of credit is provided by ICICI to indigenous manufacturers of machinery for selling their equipment on deferred payment terms. Under the IDBI scheme, usance bills/promissory notes are discounted by commercial banks who, in turn, avail of the IDBI rediscounting facility. Under the ICICI scheme, however, payment is made directly to the indigenous machinery manufactured against usance bills accepted or guaranteed by the purchaser's bank.

The salient features of the suppliers line of credit are:

- The scheme provides assistance to indigenous machinery manufacturers for sale of equipments (along with spares) to actual users for balancing, replacement, and modernisation purposes only.
- A non-revolving line of credit is extended to the seller normally with a validity period of two years from the date of sanction. Each time the seller wants to avail of the line of credit, he has to get ICICI's prior approval.

- Advances are made against usance bills duly accepted or guaranteed by the purchaser's bank.
- The amount of deferred credit is usually between 80 and 90 per cent of the value of the order—the balance is payable by the buyer as advance payment. The period of deferred credit is five to seven years and the amount is repayable in ten to fourteen equal half-yearly instalments.
- The interest rate on the suppliers line of credit facility is currently around 18 per cent per annum for a five-year facility and around 18.5 per cent per annum for a seven year facility.

Equipment Finance Scheme

To provide foreign currency loans to industrial concerns for importing capital equipments, which are not related to any specific project, IDBI and IFCI have introduced the Equipment Finance Scheme. It is available for indigenous equipments too. The salient features of this scheme are as follows:

- Concerns which intend importing capital equipment under Open General Licence or which have secured Capital Goods Committee Clearance against IDBI/IFCI lines of credit will be eligible for assistance.
- The following equipments, subject to the condition that they are new and not second hand, are eligible for assistance: capital goods; inspection equipments and tools; balancing equipments; dies; tooling; and components which are of capital nature and which are permitted to be imported under Open General Licences.
- Assistance is normally limited to the foreign exchange cost (i.e., CIF value) of the imported equipment.
- The borrower is expected to provide at least 25 per cent of the total cost of equipment. While IDBI and IFCI would provide foreign currency loan to cover the entire foreign exchange cost of imports, the borrower is expected to meet the payment of import duties and other rupee costs.

TERM LOAN PROCEDURE[1]

The procedure associated with a term loan involves the following principal steps.

Submission of Loan Application

The borrower may submit the application to any of the three term lending institutions, viz, IDBI, ICICI, and IFCI. The borrower is required to fill out a common application form which seeks comprehensive information about the project. Specifically, the common application form covers the following aspects:

- Promoters' background
- Particulars of the industrial concern
- Particulars of the project (capacity, process, technical arrangements, management

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[1] The procedure described here applies to the term loans provided by the all-India financial institutions. State-level financial institutions also follow a somewhat similar procedure.

location, land and buildings, plant and machinery, raw materials, effluents, labour, housing, and schedule of implementation)
- Cost of the project
- Means of financing
- Marketing and selling arrangements
- Profitability and cash flow
- Economic considerations
- Government consents

Initial Processing of Loan Application

When the application is received, an officer of the recipient institution reviews it to ascertain whether it is complete for processing. If it is incomplete the borrower is asked to provide the required additional information. When the application is considered complete, the recipient institution prepares a 'flash report' which is essentially a summarisation of the loan application, to be evaluated at the Senior Executive Meeting (SEM). Once the SEM, on the basis of its evaluation of the 'Flash Report', decides that the project justifies a detailed appraisal, it nominates the lead financial institution. The factors taken into account for designating the lead institution are: location of the project, prior experience of institutions in handling similar projects, representation of institutions in the state and promoter group, and existing workload of the institutions.

For the convenience of borrowers, financial institutions operate a scheme of participation for rupee term loans and underwriting assistance.[2] Under this scheme, the borrower interacts with only the lead financial institution which administers the entire loan and underwriting facility. The lead institution exercises the rights of other participating institutions as their constituent authority.

Appraisal of the Proposed Project

The detailed appraisal of the project is done by the lead institution. The appraisal covers the marketing, technical, financial, managerial, and economic aspects. The appraisal memorandum is normally prepared within two months after site inspection and placed before the Senior Executives Meeting/Inter-Institutional Meeting (SEM/IIM) for a decision about approval of the project and determining the sharing arrangement among the institutions. Once a favourable decision is taken at the SEM/IIM forum and the sharing arrangement worked out, the case is referred to the Board of Directors of the lead financial institution.

Issue of the Letter of Sanction

After the Board of Directors of the lead financial institution approves the proposal, a financial letter of sanction is issued to the borrower. This communicates to the borrower the assistance sanctioned by the lead institution and the assistance sanctioned/to be sanctioned by other participants in the consortium arrangement. Each of the participating institutions would, after approval by its Board of Directors or other appropriate authority, convey sanction of its share of assistance to the lead institution under advice to the borrower. If a participating institution is not able to make available its share of assistance, the same will be shared on a *pro rata* basis amongst the lead and other participating institutions.

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[2] Recently, however, the situation has changed. Financial institutions can now 'go it alone' or participate in consortium financing.

Acceptance of the Terms and Conditions by the Borrowing Unit

On receiving the letter of sanction from the lead financial institution, the borrowing unit convenes its board meeting at which the terms and conditions associated with the letter of sanction are accepted and an appropriate resolution is passed to that effect. The acceptance of the terms and conditions has to be conveyed to the lead financial institution within thirty days.

Execution of Loan Agreement

The lead financial institution, after receiving the letter of acceptance from the borrower, sends the drafts of the agreement to the borrower to be executed by authorised persons and properly stamped as per the Indian Stamp Act, 1899. The agreements, properly executed and stamped, along with other documents as required by the lead financial institution must be returned to it. Once the lead financial institution also signs the agreement, it becomes effective.

Disbursement of Loans

Periodically, the borrower is required to submit information on the physical progress of the project, financial status of the project, arrangements made for financing the project, contribution made by the promoters, projected funds flow statement, compliance with various statutory requirements, and fulfilment of pre-disbursement conditions. Based on the information provided by the borrower, the lead financial institution will determine the amount of term loan to be disbursed from time to time. Before the entire term loan is disbursed the borrower must fully comply with all the terms and conditions of the loan agreement.

Creation of Security

The term loans (both rupee and foreign currency) and the deferred payment guarantee assistance provided by the All-India financial institutions are secured through the first mortgage, by way of deposit of title deeds of immovable properties and hypothecation of movable properties. As the creation of mortgage, particularly in the case of land, tends to be a time consuming process, the institutions permit interim disbursements against alternate security (in the form of guarantees by the promoters). The mortgage, however, has to be created within a year from the date of the first disbursement. Otherwise the borrower has to pay an additional charge of 1 per cent interest.

Monitoring

Monitoring of the project is done at the implementation stage as well as at the operational stage. During the implementation stage, the project is monitored through: (i) regular reports, furnished by the promoters, which provide information about placement of orders,construction of buildings, procurement of plant, installation of plant and machinery, trial production, etc., (ii) periodic site visits, (iii) discussion with promoters, bankers, suppliers, creditors, and others connected with the project, (iv) progress reports submitted by the nominee directors, and (v) audited accounts of the company.

During the operational stage, the project is monitored with the help of (i) quarterly progress report on the project, (ii) site inspection, (iii) reports of nominee directors, and (iv) comparison of performance with promise.

The most important aspect of monitoring, of course, is the recovery of dues represented by interest and principal repayment.

PROJECT APPRAISAL

Financial institutions appraise a project from the marketing, technical, financial, economic, and managerial angles. The principal issues considered and the criteria employed in such appraisal are discussed below:

Market Appraisal

The importance of the potential market and the need to develop a suitable marketing strategy cannot be over-emphasised. Hence, efforts are made to:

- Examine the reasonableness of the demand projections by utilising the findings of available surveys, industry association projections, Planning Commission/DGTD projections, and independent market surveys (which may sometimes by commissioned).
- Assess the adequacy of the marketing infrastructure in terms of promotional effort, distribution network, transport facilities, stock levels, etc.
- Judge the knowledge, experience, and competence of the key marketing personnel.

Technical Appraisal

The technical review done by the financial institutions focuses mainly on the following aspects:

- Product mix
- Capacity
- Process of manufacture
- Engineering know-how and technical collaboration
- Raw materials and consumables
- Location and site
- Building
- Plant and equipments
- Manpower requirements
- Break-even point.

The technical review is done by qualified and experienced personnel available in the institutions and/or outside experts (particularly where large and technologically sophisticated projects are involved).

Financial Appraisal

The financial appraisal seeks to assess the following

(i) reasonableness of the estimate of capital cost
(ii) reasonableness of the estimate of working results
(iii) adequacy of the rate of return and
(iv) appropriateness of the financing pattern.

Reasonableness of the Estimate of Capital Cost While assessing the capital cost estimates, efforts are made to ensure that

- padding or under-estimation of costs is avoided
- specification of machinery is proper
- proper quotations are obtained from potential suppliers
- contingencies are provided
- inflation factors are considered

Reasonableness of the Estimate of Working Results The estimate of working results is sought to be based on

- a realistic market demand forecast
- price computations for inputs and outputs that are based on current quotations and inflationary factors
- an appropriate time schedule for capacity utilisation
- cost projections that distinguish between fixed and variable costs.

Adequacy of Rate of Return The general norms for financial desirability are as follows:

- Internal rate of return : 15 per cent
- Return on investment : 20-25 per cent after tax
- Debt-service coverage ratio[3] : 1.5 to 2

In applying these norms, however, a certain degree of flexibility is shown on the basis of the nature of the project, the risks inherent in the project, and the status of the promoter.

Appropriateness of the Financing Pattern The institutions consider the following in assessing the financing pattern:

- A general debt-equity ratio norm of 1.5:1
- A requirement that promoters should contribute $12\frac{1}{2}\%$ to $22\frac{1}{2}\%$ of the project cost
- Stock exchange listing requirements
- The means of the promoter and his capacity to contribute a reasonable share of the project finance.

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[3] The debt-service coverage ratio for any year is defined as:

$$\frac{\text{Profit after tax} + \text{Depreciation} + \text{Interest on long-term loan}}{\text{Interest on long-term loan} + \text{Loan repayment instalment}}$$

The average debt service coverage ratio over the period for which the term loan is repayable is calculated. It should ordinarily be between 1.5 and 2.0.

Economic Appraisal

The economic review looks at the project from the larger social point of view. The methodology adopted by the financial institutions for the purpose of economic evaluation (also referred to as social cost benefit analysis) is labelled as 'Partial Little Mirrless' approach. In addition to the calculation of the economic rate of return as per this approach, they also look at two other economic indicators: (i) effective rate of protection, and (ii) domestic resource cost.

Admittedly, the economic review done by financial institutions is not very rigorous and sophisticated. Also, the emphasis placed on this review is rather limited. Yet, a beginning has been made. Hopefully, on the basis of the experience gained, the methodology would be improved and the emphasis increased.

Managerial Appraisal

In order to judge the managerial capability of the promoters, the following questions are raised:

- How resourceful are the promoters?
- How sound is the understanding of the project by the promoters?
- How committed are the promoters?

Resourcefulness This is judged in terms of the prior experience of the promoters, the progress achieved in organising various aspects of the project, and the skill with which the project is presented.

Understanding This is assessed in terms of the credibility of the project plan including, *inter alia*, the organisation structure, the estimated costs, the financing pattern, the assessment of various inputs and the marketing programme, and the details furnished to the financial institution.

Commitment This is gauged by the resources (financial, managerial, managerial, and other) applied to the project and the zeal with which the objectives of the project, short-term as well as long-term, are pursued. Managerial review also involves an assessment of the calibre of the key technical and managerial personnel working on the project, the schedule for training them, and the remuneration structure for rewarding and motivating them.

KEY FINANCIAL INDICATORS

The key financial indicators used by financial institutions while evaluating projects are the internal rate of return, the debt service coverage ratio, and the break-even point. In addition, some other indicators are employed as well. The manner in which these indicators are calculated is discussed below.

Internal Rate of Return

For calculating the internal rate of return of a project, its cash outflows and cash inflows are defined as follows:

Cash Outflows

Outlay on fixed assets : Cost of project
— Working capital margin
— Interest during construction period

Outlay on current assets : Current asset investment in the beginning as well as additional investment in current assets in future.

Cash Inflows

Operating inflows : Earnings before depreciation, interest, and taxes (EBDIT)

Terminal inflow : Residual value of fixed assets[4]
+
Realisable value of current assets[5]

An illustrative stream of cash flows for a project is given below:

Year	Cash outflows		Cash inflows		Net cash flow
0	Cost of project	114.4			
	— Margin for working capital	8.5			
	— Interest during construction	5.0			
		100.9			(100.9)
1	Investment in current assets	29.2	EBDIT	25.8	(3.4)
2	Increase in current assets	5.8	EBDIT	32.1	26.3
3	Increase in current assets	6.2	EBDIT	37.2	31.0
4			EBDIT	36.6	36.6
5			EBDIT	36.0	36.0
6			EBDIT	35.3	35.3
7			EBDIT	34.5	34.5
8			EBDIT	33.8	33.8
9			EBDIT	32.9	32.9
10			EBDIT	32.1	
			Residual value of land	4.7	
			Residual value fixed assets	5.0	
			Residual value of current assets	41.2	83.0

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[4] The residual value of depreciable fixed assets is equated to 5 per cent of the initial cost whereas the residual value of land is set equal to its initial cost.

[5] Current assests are assumed to be realised at par.

The internal rate of return for the above project is the value of r in the following equation.

$$100.9 + \frac{3.4}{(1+r)} = \frac{26.3}{(1+r)^2} + \frac{31.0}{(1+r)^3} + \frac{36.6}{(1+r)^4} + \frac{36.0}{(1+r)^5} + \frac{35.3}{(1+r)^6}$$

$$\frac{34.5}{(1+r)^7} + \frac{33.8}{(1+r)^8} + \frac{32.9}{(1+r)^9} + \frac{83.0}{(1+r)^{10}}$$

The solving value of r is approximately 23 per cent.

In general, if a project has an internal rate of return of 15 per cent or more it is considered worthwhile.

Debt Service Coverage Ratio

The debt service coverage ratio is defined as:

$$\frac{\text{Profit after tax} + \text{Depreciation} + \begin{array}{c}\text{Other non-}\\ \text{cash charges}\end{array} + \begin{array}{c}\text{Interest on}\\ \text{term loan}\end{array}}{\text{Interest on term loan} + \text{Repayment of term loan}}$$

Financial institutions calculate the average debt service coverage ratio for the period during which the term loan is repayable. Exhibit C.1 illustrates the calculation of the debt service coverage ratio.

Normally, financial institutions regard a debt service coverage ratio of 1.5 to 2 as satisfactory. If this ratio is less than 1.5 and the project is deemed otherwise desirable, a term loan of a longer maturity may be provided. By the same token, if this ratio is significantly higher than 2, the maturity period of the loan may be shortened.

Break-even Point

The break-even point for a project is calculated with reference to the year when the project is expected to reach its target (or expected) level of capacity utilisation, which is usually the third of the fourth operating year.

To illustrate the calculation of the break-even point consider the following data for the third year of a project, when it is expected operate at 70 per cent of its installed capacity. (The installed capacity of this project is 2880 tonnes per annum and 70 per cent of this is 2016 tonnes per annum.)

EXHIBIT C.1

Debt Service Coverage Ratio

Rs in million

Year	1	2	3	4	5	6	7	8	9	10
A *Total Cash Accrual*										
1 Profit after tax	0.27	0.81	1.35	1.13	0.99	0.99	0.99	1.01	1.02	1.04
2 Depreciation	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
3 Interest on term loan	1.18	1.18	1.07	0.93	0.78	0.64	0.48	0.33	0.19	0.04
Total of A	2.15	2.69	3.12	2.76	2.47	2.33	2.17	2.04	1.91	1.78
B *Debt Service Requirements*										
1 Interest on term loan	1.18	1.18	1.07	0.93	0.78	0.63	0.48	0.33	0.19	0.04
2 Repayment of term loan	–	0.4	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.4
Total of B	1.18	1.58	1.87	1.73	1.58	1.43	1.28	1.13	0.99	0.44
D.S.C.R. (A/B)	1.82	1.70	1.67	1.60	1.56	1.63	1.70	1.81	2.01	4.05

Average D.S.C.R = 1.96

A *Variable Cost*	
• Raw materials and consumables	157.2
• Power	9.7
• Selling expenses	24.2
• Interest on working capital	5.8
	196.9
B *Fixed Cost*	
• Wages and salaries	12.0
• Factory overheads	0.6
• Administration expenses	1.0
• Interest on term loans	10.7
• Depreciation	7.0
• Preliminary expenses written off	0.2
	31.5
C *Sales Realisation*	241.9
D *Contribution*	45.0

Using the above data, three measures of the break-even point (BEP) are calculated.

$$\text{BEP in terms of volume of production} = \frac{\text{Fixed cost}}{\text{Contribution}} \times \text{Target volume}$$

$$= \frac{31.5}{45.0} \times 2016 \quad = \text{1411 tons}$$

$$\text{BEP in terms of installed capacity} = \frac{\text{Fixed cost}}{\text{Contribution}} \times \text{Target capacity utilisation}$$

$$= \frac{31.5}{45.0} \times 70\% \quad = 49\%$$

$$\text{BEP in terms of amount of sales} = \frac{\text{Fixed cost}}{\text{Contribution}} \times \text{Sales realisation}$$

$$= \frac{31.5}{45.0} \times 241.9 \quad = \text{Rs 16.93 million}$$

Other Indicators

Financial institutions look at the following indicators too:

$$\text{Profit margin on sales} = \frac{\text{Net profit after tax}}{\text{Sales}}$$

$$\text{Return on owners' equity} = \frac{\text{Net profit after tax}}{\text{Promoters' contribution + Soft loan}}$$

$$\text{Fixed assets coverage ratio} = \frac{\text{Net fixed assets + Capital work-in-progress}}{\begin{array}{l}\text{Deferred credits + Term loans + Debentures}\\ \text{secured by first charge over fixed assets + Other}\\ \text{loans having pari passu charge over fixed assets}\end{array}}$$

$$\text{Debt equity ratio} = \frac{\text{Long term debt}}{\text{Equity}}$$

$$\text{Current ratio} = \frac{\text{Current assets}}{\text{Current liabilities}}$$

$$\text{ROI after taxes} = \frac{\begin{array}{c}\text{Profit after tax + Depreciation + Interest on term loan}\\ \text{(1 − tax rate)}\end{array}}{\text{Cost of project}}$$

$$\text{ROI before taxes} = \frac{\text{Profit before tax + Depreciation + Interest}}{\text{Cost of project}}$$

APPENDIX D

Assessing the Tax Burden*

For preparing the estimates of working results, the expected tax burden for the forecast period, which is usually eight to ten years, has to be figured out. This calls for familiarity with the provisions of the Income Tax Act that are relevant for determining the magnitude and timing of the tax burden for a new project. This appendix, seeking to provide help in this respect, is organised into four sections. The first section discusses the broad framework for deriving the taxable income; the second dwells on some important provisions relevant for computing the taxable income; the third focuses on the determination of tax burden and payment of tax; and finally, the fourth presents a comprehensive illustration of tax calculation. It should be emphasised here that taxation is a complex and specialised field which is best handled by experts. Our purpose here is to build a basic understanding of the tax framework relevant for financial appraisal of projects and not to provide a detailed exposition of the field.

FRAMEWORK FOR DERIVING TAXABLE INCOME

Income tax is a charge calculated by applying the rates prescribed annually in the Finance Act on the base called the total income. The total income, also known as taxable income, is computed with reference to a period defined as the previous year. Exhibit D.1 shows the schematic diagram for determining the total income of a corporate assessee under the Income Tax Act (Act hereafter). Before we discuss these elements, it may be noted that as part of measures of simplification, the Income Tax Act is being amended to do away with incentive schemes like investment allowance/investment deposit, reduce depreciation allowance, and reduce the corporate income tax rates. This is based on the argument that since incentives reduce the effective rate of income tax while creating in its wake complexities, it is preferable to reduce directly the nominal rates of taxes which will make administration of tax law less complicated.

Income from Business

This broadly consists of receipts less deductions associated with activities which can be attributed with the character of business/profession. The principal sources of receipts are sale proceeds, professional fees, and labour charges.

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* This appendix has been contributed by Prof. S. Sundararajan of IIM Bangalore.

EXHIBIT D.1

Schematic Diagram for Determining the Total Income for Corporate Assessees

Income from Business

+

Income from Other Heads under Tax Law

=

Gross Total Income

–

Deductions from Gross Total Income

=

Total Income

The deductions can be classified as follows:

1. *Actual business expenses incurred* The major items included under this head are: (i) rent, rates, taxes, insurance, repairs and maintenance in respect of buildings (Section 30)[1]; (ii) repairs, maintenance and insurance in respect of plant and machinery (Section 31); (iii) expenditure on scientific research not being in the nature of capital expenditure related to the business of the assessee (Section 35); (iv) insurance premium paid in respect of insurance of stock or stores of the business; bonus, commission and contribution to provident fund and other recognised funds in respect of employees; interest on capital borrowed for the purpose of business; bad debt etc. (Section 36); (v) any other expenditure (not being in the nature of capital expenditure or personal expenses of the assessee) laid out or expended wholly and exclusively for the purposes of the business or profession (Section 37).
2. *Amortisation of certain expenses* In respect of the following cases of lump sum expenses incurred at one time, a percentage of such expenses is allowed to be deducted against the income over a number of years by way of amortisation: (i) depreciation of fixed assets at the rates prescribed under Rule 5 of the Income Tax Rules (Section 32); (ii) expenditure on patents and copyrights (Section 35A); (iii) expenditure for acquiring know-how (Section 35 AB); (iv) amortisation of preliminary expenses (Section 35D); (v) expenditure on prospecting of minerals (Section 35E); (vi) capital expenditure on family planning of employees (Section 36).
3. *Capital expenditures of certain types* Though capital expenditures are not normally allowed as a deduction in computing the business income, the following capital

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[1] Sections refer to the Sections of the Income Tax Act, 1961 as amended by the Finance Act 1994.

expenditures can be deducted by virtue of certain provisions of the Act: (i) capital expenditure on scientific research related to the business carried on by the assessee [Section 35 (1) (iv)]; (ii) capital expenditure incurred in connection with the business consisting of prospecting for or extraction or production of mineral oils (Section 42).

4. *Certain contributions* Payments made to (a) certain recognised scientific research institutions to be used for scientific research [Section 35 (1) (ii)]; (b) certain recognised institutions to be used for research in social science or statistical research [Section 35 (1) (iii)]; (c) approved public sector company or any other association/institution for promoting the social and economic welfare of, or the uplift of the public (Section 35 AC); and (d) certain associations and institutions for carrying out programmes of conservation of natural resources (Section 35 CC B) can be deducted for tax purposes. In respect of contributions made to approved National Laboratories with a specific direction that the amounts be used for scientific research undertaken under an approved programme, an amount equal to 125% of the contribution is allowed as a deduction.
5. *Carried forward losses and allowances* In computing the business income, losses and allowances carried forward from the previous years can be deducted subject to compliance with certain conditions.

Income from Other Heads Under Tax Law

The various other heads, the nature of income, and the deductions allowed under these heads by the Act are shown below:

Head	Nature of Income	Deductions Allowed
Income from house property	Income arising from building and land appurtenant thereto owned by the assessee	Deductions are specified under Sections 23 and 24 of the Act
Capital gains	Full value of consideration on transfer of capital assets	(a) Indexed cost of acquisition of the assets (b) Indexed cost of improvements (c) Expenses on transfer (d) Certain exemptions
Income from other sources	Interest, dividends and other incomes which cannot be taken under any other head	Expenses incurred to earn the income and depreciation where applicable

Gross Total Income

This represents the summation of income from business and income from other heads under the Act as described above. This aggregation process involves setting off negative figures in the manner as prescribed in the Act. Such set off is done at two levels as follows:

(a) setting off negative figures under any source against positive figures under any other source within the same head of income; and
(b) setting off negative figures under any head of income against positive figures under any other head of income.

These provisions are discussed separately in the next section.

Deductions from Gross Total Income

Chapter VI A of the Act deals with various deductions that are allowed from the gross total income. The deductions under this chapter are different from those deductions discussed earlier in the sense that while those deductions are specifically linked to the head of income the deductions under Chapter VI A are allowed regardless of the head from which the income is derived.

It should be noted that these deductions cannot make the gross total income a negative figure. Put differently, if the gross total income happens to be a negative figure, no deduction is available under Chapter VI A.

The important deductions under Chapter VI A are as follows:

1. Deduction in respect of profits and gains from projects outside India (Section 80 HHB);
2. Deduction in respect of profits from export business (Section 80 HHC);
3. Deduction in respect of earnings in convertible exchange (Section 80 HHD);
4. Deduction in respect of profits from export of computer software etc. (Section 80 HHE);
5. Deduction in respect of profits and gains from new industrial undertakings after a certain date etc. (Section 80 IA);
6. Deduction in respect of profits and gains from business of poultry farming (Section 80 JJ);
7. Deduction in respect of certain inter-corporate dividends (Section 80 M);
8. Deduction in respect of royalties etc., from certain foreign companies (Section 80 O);
9. Deduction in respect of profits and gains from the business of publications of books (Section 80 Q).

Total Income

This represents the difference between the gross total income and the deductions from the gross total income and is the base on which the tax rate is applied to arrive at the tax liability.

IMPORTANT PROVISIONS AND CONSIDERATIONS RELEVANT FOR DERIVING TAXABLE INCOME

In applying the framework for deriving the taxable income, discussed in the preceding section, certain provisions and considerations relating to the following must be borne in mind:

- Expenses incurred during construction period
- Depreciation

- Deduction in respect of expenditure on scientific research
- Deduction in respect of profits from export business
- Deduction in respect of profits and gains from newly set up industrial undertakings
- Disallowances
- Set off, carry forward, and order of deduction for computing income from business

Expenses Incurred During Construction Period

During the construction stage of a project, especially the one launched by a new company, various expenses are incurred. Those expenses which are directly related to the construction are considered as part of the plant, machinery, building etc. The treatment of expenses other than such direct expenses requires consideration. Before we discuss them, a preliminary question has to be answered: what is the date from which the computation of profits and gains of the business should be reckoned for purposes of income tax? Section 3 of the Act dealing with the definition of previous year (the period with reference to which total income is computed) provides a clue in the matter. According to this Section, the previous year in respect of any business commences from the date on which it is 'set up'. In the case of a factory, the date of 'set up' will be the date on which the unit is 'ready' to commence production after trial run, etc., though the actual commercial production may not start due to various reasons such as non-availability of raw material, power supply etc. This date of 'set up' is the cut off date and all the expenditures incurred after this date is to be treated as revenue expenditure deductible in computing the income from business. It may not matter at this stage whether the unit is effecting sales or not for computing income under the head 'Profits and Gains of Business or Profession' for the purposes of income tax.

Once the date of 'set up' of business is determined, the treatment of various expenses incurred up to the date of the setting up of the unit (other than direct expenses relating to construction) may be discussed. These expenses may be classified as follows: (i) preliminary expenses, (ii) indirect expenditure relating to construction, (iii) indirect expenditure not relating to construction, (iv) expenditure relating to technical know-how, (v) expenditure relating to a new project of an existing company, and (vi) income earned during the construction period.

Preliminary Expenses Preliminary expenses consist of the following: (a) expenditure in connection with preparation of feasibility report, preparation of project report, market survey or any other survey necessary for the business of the assessee, and engineering services related to the business of the assessee; (b) legal charges for drafting any agreement between the assessee and any other person for any purpose relating to the setting up or conduct of the business of the assessee; (c) legal charges for drafting the memorandum and articles of association, fees for registration of the company under the provisions of the Companies Act, cost of issue for public subscription, of shares and debentures of the company; (d) such other items of expenditure (not being expenditure eligible for any allowance or deduction under any other provision of this Act) as may be prescribed.

According to Section 35D of the Act, 10 per cent of the preliminary expenses can be claimed as deduction for each of the ten successive previous years beginning with the previous year in which the business commences or the extension of the industrial undertaking is completed. The maximum amount of preliminary expenses that can be amortised is two-and-a-half per cent of the cost of the project or capital employed (as defined in Section 35 D) whichever is more.

Indirect Expenditure Relating to Construction These consist of expenses like financial charges, remuneration of various personnel engaged in construction activity, travailing and other expenses incurred for the purpose of implementing the project, depreciation on various assets used for the purpose of construction and trial production expenses. These expenses are allowed to be capitalised, i.e., added to the value of various assets set up by allocating them over the items of plant, machinery, buildings, etc., on some reasonable basis. The unit is permitted to claim depreciation on the enhanced value of these assets arrived at after such allocation and this value is referred to as the 'actual cost' of the assets. Such actual cost is reduced by that portion, if any, as has been met directly or indirectly by any other person or authority [Section 43(1)].

Indirect Expenditure not Relating to Construction There are several expenses incurred during the construction period which are not in any way related to construction. Examples: expenses on the marketing department, expenses incurred due to the corporate status of the unit. Such expenses are not allowed to be capitalised nor are they allowed to be deducted from the income of the subsequent years. From the point of view of financial accounting, these expenses are treated as deferred revenue expenses and are written off over a period of time. From the income tax point of view, however, the company does not derive the benefit of charging these expenses against revenue. Hence it is preferable that such expenses are incurred, as far as possible, after the date of setting up of the unit.

Expenditure on Technical Know-how Lump sum consideration paid in any year for acquiring any technical know-how can be claimed as deduction under Section 35 AB at 1/6 for 6 years (1/3 for 3 years in certain special cases) commencing from the year of payment. Alternatively, expenditure incurred on technical know-how could be capitalised as a direct expenditure related to construction or could be by itself treated as a plant on which depreciation could be claimed.

Expenditure Relating to a New Project of an Existing Company When an existing company with ongoing business activities sets up a new project, expenses which are directly relatable to the construction of the project is capitalised. Other indirect expenses incurred during the construction period are allowed to be claimed as a deduction from the incomes earned from other existing activities of the company. However, this does not preclude the company from capitalising all indirect expenses relating to construction without claiming it as a deduction from other incomes as aforesaid.

Income Earned During Construction Period Income earned during construction period which is attributable to construction activity can be reduced from the Indirect Expenses relating to construction. Examples of such income are sale of products produced during trial run, sale of packing material used for machinery etc. Other types of incomes like interest received, share transfer fees received etc., are normally treated as income for the purpose of Income-Tax Act.

Depreciation

According to Section 32 (1) of the Income-Tax Act, depreciation at prescribed rates on the actual cost (determined in the manner stated in the preceding heading) in respect of buildings, plant and machinery and furniture and fittings used for business/professional purposes is a tax deductible expense. For claiming depreciation allowance the assets should be owned and used for the purpose of business by the assessee.

When a capital asset is imported by incurring a liability in foreign exchange and the rupee equivalent of such liability outstanding at the end of each year or at the time of repayment increases/decreases due to fluctuation in rates of exchange then such increases/decreases are adjusted against the actual cost (Section 43A). The actual cost so adjusted at the end of each year is treated as if it was the actual cost from the date of acquisition of the asset. This necessitates adjustment toward depreciation in each year in respect of the earlier years.

Depreciation is charged on blocks of assets which represent a group of assets, within the broad class of assets, of buildings, plant, machinery and furniture, for which a common rate of depreciation is applicable. Depreciation will be calculated by applying the prescribed rate (which varies between 5% and 100 per cent) on the written down value (WDV) of the entire block. When an asset is sold the amount realised from the sale of such asset (after deducting expense on sales) will simply be deducted from the WDV of that block. If the amount realised is greater than the WDV of the block, the difference will be treated as short term capital gain. In a case where all the assets in the block are disposed off and there is still a balance in the account of the block, such amount will be treated as short term capital loss.

To illustrate the above provisions, let us consider an example. A block of assets consisting of 10 items acquired during 1985 to 1992 has a written down value of Rs 3 million as on 1st April 1992. During 1992-93, the assessee sells an asset for Rs 2 million (on which an expense of Rs 0.1 million is incurred on sale) and acquires an asset for Rs 0.5 million. The net block of assets for depreciation purposes at the end of 1992-93 will be:

Opening WDV	Rs 2 million
Value of addition during the year	Rs 0.5 million
	Rs 2.5 million
Less	
Sale proceeds (after deducting selling expense) for the asset sold	Rs 1.9 million
Net block for purposes of depreciation	Rs 0.6 million

In the above example, if the sale proceeds (after deducting selling expense) had been Rs 5 million, the difference between this amount and Rs 2.5 million should be treated as short-term capital gain and the net block for purposes of depreciation will be zero. Suppose, all the assets in the block (including the assets acquired during the year) are sold for Rs 2.2 million (after deducting selling expenses), the balance of Rs 0.3 million remaining in the block account will be treated as short-term capital loss.

It may be noted that when any asset is acquired and put to use during the previous year for a period less than 180 days then depreciation will be allowed only to the extent of 50 per cent of the prescribed rate for that asset in respect of the year of acquisition.

Deduction in Respect of Expenditure on Scientific Research

Under Section 35, the following expenses relating to scientific research incurred during the previous year are allowed as deduction in computing the income from business:

1. All expenses, both revenue and capital (other than cost of land) incurred on scientific research relating to the business of the assessee. Such expenditures incurred within three years before the commencement of business shall also be deemed to be incurred in the year of commencement of business and accordingly deductible in that year.

2. Contribution to approved scientific research associations/institutions to be used for scientific research. In respect of contributions made to approved National Laboratories with a specific direction that the amounts be used for scientific research undertaken under an approved programme, an amount equal to 125% of the contribution is allowed as a deduction.
3. Contribution to approved institutions to be used for research in social science or statistical research.

Deduction in Respect of Profits Derived from Export Business

Section 80 HHC allows deduction of the whole of the profits derived from export business. Various conditions governing the grant of this deduction are as follows.

1. The assessee should be engaged in the business of export out of India of any goods and merchandise. Exports of mineral oils, and minerals and ores (other than processed minerals and ores specified in the twelfth schedule to the Income-Tax Act) do not qualify for this deduction.
2. The sale proceeds from exports of such goods are receivable by the assessee in convertible foreign exchange within a period of six months or such extended time given by the Chief Commissioner of Income-tax, from the end of the previous year in which the export took place.
3. The profits derived from export business (hereinafter referred to as exempted profits) is determined under 3 cases, viz. where the exported goods are manufactured or processed by the assessee, where the exported goods are trading goods and where the exported goods consist of both types.

Case 1: Export of manufactured goods

$$\text{Exempted Profit} = \text{Profit of the business} \times \frac{\text{Export Turnover}}{\text{Total Turnover}}$$

Case 2: Export of trading goods

Exempted Profit = Export turnover of trading goods − Direct and Indirect costs attributable to export of such goods.

Case 3: Export of both manufactured and trading goods

(a) For manufactured goods:

$$\text{Exempted Profit} = \text{Adjusted profit of the business} \times \frac{\text{Adjusted Export Turnover}}{\text{Adjusted Total Turnover}}$$

(b) For trading goods:

Exempted Profit = Export turnover of trading goods − Direct and Indirect costs attributable to export of such goods.

Note: For purposes of making the above computations various expressions used thereunder have the meanings as stated below:

(a) 'Total Turnover' does not include freight, insurance and export incentives;

(b) 'Export Turnover' means the sale proceeds received in India in convertible foreign exchange within six months of the previous year or such extended time limit but does not include freight and insurance;

(c) 'Profits of the Business' means the amount computed under the head 'Profits and Gains of Business or Profession' and reduced by (i) 90 % of the export incentives, brokerage, commission, interest, rent or receipt of similar nature included in such profit and (ii) the profits of any branch office, warehouse or any other establishment of the assessee situated outside India;

(d) 'Direct Costs' means costs directly attributable to the exported trading goods including the purchase price of such goods;

(e) 'Indirect Costs' means costs, not being direct costs, allocated in the ratio of the export turnover of trading goods to the total turnover;

(f) 'Adjusted Total Turnover' means the total turnover of the business as reduced by the export turnover of trading goods;

(g) 'Adjusted Export Turnover' means the export turnover as reduced by the export turnover of trading goods;

(h) 'Adjusted Profits of the Business' means the profits of the business as reduced by the profits derived from the business of export of trading goods.

4. An assessee selling the eligible goods to an Export/Trading House holding a valid certificate issued by the Chief Controller of Imports and Exports is also entitled to the deduction as stated above on the basis of a certificate of export turnover issued by such Export/Trading House and a Chartered Accountant. On issue of such certificate, the amount of deduction available to the Export/Trading House will be reduced by the amount calculated as follows:

$$\frac{\text{Export turnover certified}}{\text{Total export turnover}} \times \text{Total profit of the export business}$$

5. A certificate from a Chartered Accountant certifying that the deduction has been correctly claimed is to be furnished along with the return of income.

Deduction in Respect of Profits and Gains from Newly Set up Industrial Undertakings

Section 80 IA allows a certain deduction in respect of the profits and gains derived from any newly set up industrial undertaking, or a ship or the business of a hotel referred to as eligible business. For purposes of computing the amount of deduction, such industrial undertakings, or ship or the business of the hotel is treated as if it was the only source of income.

1. The allowable deductions are as follows:

(i) *Industrial undertakings* For initial assessment year and nine succeeding assessment years the deduction allowed is @ 30% of profits and gains derived from such industries. In the case of industrial undertakings located in an industrially backward state or district as specified or set up in any part of India for the generation, or generation and distribution, of power which begins to manufacture or produce articles or things or to operate its cold storage plant or plants or to generate power at any time during the period from 1st April, 1993 to 31st March, 1998, the deduction will be 100% for the first five years instead of the aforesaid 30%.

(ii) *Hotels* 30% of the profits and gains from hotels for initial assessment year and nine succeeding assessment years. When the hotel is set up during 1st April, 1990 and 31st March, 1993 in hilly area, rural area or place of pilgrimage or any other approved place, the deduction allowed is @ 50% of the profits and gains.

(iii) *Ships* 30% of the profits and gains from the operation of the ships for the initial assessment year and nine succeeding assessment years.

For computing the profits of the eligible business as aforesaid, past losses and unabsorbed allowances relating to such business is deducted even though such past losses, etc., have already been absorbed by the other incomes in the past.

2. This section applies to an industrial undertaking which fulfills the following conditions:
   (i) It is not formed by the splitting up, or reconstruction, of a business already in existence.
   (ii) It is not formed by the transfer to a new business[2] of a machinery or plant previously used for any purpose[3].
   (iii) In the case of an industrial undertaking other than a small scale industry or an industry set up in a backward state, it manufactures or produces any articles or things other than articles or things specified in the list in the Eleventh Schedule;
   (iv) It begins to manufacture or produce articles or things or to operate cold storage plant or plants, at any time within the period of four years next following the 31st day of March, 1991 or such further period as may be notified by the Government with reference to any particular industrial undertaking; and
   (v) It employs ten or more workers in a manufacturing process carried on with the aid of power or employs twenty or more workers in a manufacturing process carried on without the aid of power.
3. This section applies to a ship where the following conditions are fulfilled:
   (i) It is owned by an Indian company and is wholly used for the purpose of the business carried on by it;
   (ii) It was not, previous to the date of its acquisition by the Indian company, owned or used in Indian territorial waters by a person resident in India; and
   (iii) It is brought into use by the Indian company at any time within the period of four years next following the 1st day of April, 1991.
4. This section applies to the business of a hotel where the following conditions are fulfilled.
   (i) The business of the hotel starts functioning after 31st March, 1991 but before 1st April, 1995;

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[2] Where the industrial undertaking is formed by transfer to a new business of any machinery or plant previously used for any purpose and the value of such machinery or plant does not exceed 20 per cent of the total value of the machinery or plant used in the eligible business, the benefit will be available to the industrial undertaking.

[3] Any machinery or plant which was used outside India by any person other than the assessee shall not be regarded as machinery or plant previously used for any purpose, provided that (i) such machinery or plant was imported into India from any country outside India, (ii) no depreciation for any period prior to date of installation by the assessee in respect of the said asset has been allowed to any person under this Act, and (iii) the said asset was not used in India at any time previous to the date of installation by the assessee.

(ii) The hotel is not formed by the splitting up, or the reconstruction, of a business already in existence or by the transfer to a new business of building previously used as a hotel or any of machinery or plant previously used for any purpose;

(iii) The business of the hotel is owned and carried on by a company registered in India with a paid-up capital of not less than five hundred thousand rupees; and

(iv) The hotel is for the time being approved by the Central Government.

Disallowances

The Income Tax Act provides that though certain expenses are incurred by the assessee during the previous year, they will not be allowed as a deduction (partly or fully) in computing the income under the head 'Profits and gains of Business or Profession' under certain circumstances. The more important of these items are mentioned below:

1. In respect of entertainment expenditure, if the expenditure does not exceed Rs 10,000, the whole of the actual expenditure is allowed as a deduction. If the expenditure exceeds Rs 10,000 then only 50% of such excess is allowed as deduction {Section 37 (2A)};
2. Advertisement expenditure in the material published by any political party is disallowed in full [Section 37 (2B)].
3. Expenditure in the form of articles presented is allowed in full up to Rs 1,000 per article and in excess of Rs 1,000, only 50% of such excess is allowed [Section 37(3)];
4. Expenses on stay during travel is allowed in full up to Rs 1,500 per day and in excess of Rs 1,500 per day, only 50% of such excess is allowed [Section 37(4)];
5. Expenditure on the maintenance of guest house including depreciation on guest house buildings, equipments, furniture, etc., is disallowed wholly [Section 37 (4)].
6. Expenditure on account of supply of goods, services, or facilities by certain specified related persons/organisations, which in the opinion of the assessing officer is excessive or unreasonable can be disallowed [Section 40A (2)].
7. Expenditure in respect of which payment is made in a sum exceeding Rs 10,000, at a time, otherwise than by crossed cheque or bank draft (except in certain exempted cases) is disallowed in full [Section 40A (3)].
8. Contributions to unapproved gratuity or other funds of employees are disallowed in full [Section 40A (7 and 9)].
9. Expenditures of the following kind are disallowed if they are not paid for within the previous year or within a stipulated time after the previous year: (a) expenses on account of tax, duty, or fees, (b) contributions to any provident/superannuation/gratuity/other welfare fund of employees, (c) payment of bonus or commission to employees, and (d) interest on any loan or borrowing from public financial institution (as defined in Section 4A of the Companies Act, 1956) (Section 43B)[4].

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[4] It may be noted that this section makes an exception to the general principle of allowing expenditures as a deduction in the previous year in which they are incurred, irrespective of whether they are paid or not.

Set off, Carry Forward, and Order of Deduction for Computing Income from Business

Various deductions and allowances are considered in computing the income from business as discussed in the first section. If the result after providing for such deductions and allowances is a negative figure in any year, this is allowed to be set off against income from other heads and the remaining unabsorbed amount, if any, can be carried forward to the next year and set off against the income of that year and so on. The provisions relating to set off of negative income and aggregation can be discussed under (i) set off amongst various heads of income and carry forward, and (ii) order of deduction for computing income from business.

Set off Amongst Various Heads of Income and Carry Forward (i) The first step in the aggregation process is the determination of income under each head by setting off losses against incomes under different sources. The rules for such set off are as follows:

(a) Losses from any source under a given 'head of income' can be set off only against income from any other source under the same 'head of income', with two exceptions noted in (b) below.

(b) Losses from speculation business (which falls under the head of income 'profits and gains of business or profession') can be set off only against profits from speculation business. Likewise losses from owning and maintaining race horses can be set off against profits from similar activity.

(ii) Aggregation of income from all heads of income is done by setting off losses from one head of income against income from other head/s. The rules regarding set off and carry forward are as follows:

(a) Subject to (i) above losses under any head of income other than the head capital gains can be set off against the income under any other head of income. Losses under the head house property to the extent it relates to the interest on loan taken for construction, purchase or repair of such property can be set off against income from any other head. Losses that remain unabsorbed under the head house property and other sources lapse with that year and not allowed to be carried forward.

(b) Losses that remain under the head capital gains can be carried forward and set off against income under the head capital gains of subsequent years and so on. Such carry forward can be done for a period of eight subsequent years from the year in which the loss was computed.

(c) Unabsorbed business loss (other than speculation business loss) of any year can be carried forward and set off against income under the head of business of subsequent years, provided the business under which the loss was originally computed is continued to be carried on in the year in which the set off is sought. Such carry forward can be done for eight subsequent years from the year in which the loss was computed.

(d) Unabsorbed loss from speculation business can be carried forward and set off against income from speculation business. Such carry forward can be done for eight subsequent years.

(iii) Unabsorbed depreciation can be carried forward and set off against the income from any other head of subsequent years without any limitation as to the number of years.

(iv) Capital expenditure on scientific research which is not absorbed by available current profits is treated in the same way as unabsorbed depreciation.

Order of Deduction for Computing Income from Business For the purposes of carry forward and set off, the unabsorbed benefits from an earlier year are divided into various categories and are considered for set off, along with certain current allowances, in the order given below in computing the income from business of the current year:

- Current depreciation
- Current capital expenditure on scientific research
- Carried forward business loss
- Unabsorbed depreciation and unabsorbed capital expenditure on scientific research
- Carried forward investment allowance

DETERMINATION OF THE TAX BURDEN AND PAYMENT OF TAX

Once the taxable income of the company is derived, the next step is the determination of the tax burden and its payment. For this purpose, we need to know: (i) tax rates for companies, (ii) provisions for payment of advance tax; and (iii) provisions for payment of tax along with the filing of return.

Tax Rates for Companies

For tax purposes, companies are classified as domestic companies and foreign companies and are taxed at 40% and 55% respectively. Though the rates of income-tax are prescribed annually in the Finance Act, the Income Tax Act itself stipulates the rates of income tax in respect of certain types of incomes and these generally relate to foreign companies in respect of incomes of the nature of royalties, technical know-how fees, interest and dividends. In respect of long term capital gains, the Act prescribes rates of tax both for domestic as well as foreign companies.

Such incomes are taxed at the rates mentioned in the Act and the remaining total income is taxed at the rates stated above. In the case of domestic companies whose total income exceeds Rs 75,000, the total tax liability computed in the manner stated above is increased by an amount equal to 15% of such total tax towards surcharge.

Provision for Advance Tax

Advance tax is payable on the current income of the company in four instalments during the financial year as follows:

On or before	**Advance tax that should have been paid by the due date (as a percentage of the estimated total tax liability)**
15th June	15
15th September	45
15th December	75
15th March (succeeding)	100

For practical purposes, these provisions mean that income tax is payable along with the earnings. Thanks to this 'pay as you earn' principle, there is hardly any lag between earnings and tax payment.

Payment of Taxes Along with Filing of Return

At the time of filing of return, the assessee is required to compute the tax liability based on the income stated in the return of income. If there is a shortfall between this tax liability and the sum of the advance tax paid and the tax deducted at source on incomes due to the company, then such shortfall is required to be paid before the return is filed. Such tax is referred to as self assessment tax. Along with such shortfall in tax the assessee is also required to pay interest on (a) the shortfall in the advance tax payable in any instalment and (b) the self assessment tax, if the return is filed beyond the due date. The due date for filing of return for companies is 30th November of the relevant assessment year.

ILLUSTRATION OF TAX CALCULATION

(All figures in millions)

Nuts and Bolts Ltd., set up its factory on 10.10.1992 for the manufacture of Fasteners. Following details are available.

1. The balance sheet of the company as on 10.10.1992 is as follows:

Liabilities		*Assets*	
Share Capital	8.00	Plant and Machinery	7.00
Central Subsidy	1.50	Building	9.00
Term Loan	10.50	Current Assets, Loans and Advances etc.	1.00
Deposits	3.00	Preliminary and Preoperative expenses	6.00
	23.00		23.00

2. The projected revenues and expenses for eight years ending 31st March are:

REVENUES:

1	2	3	4	5	6	7	8
10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00

EXPENSES:

1	2	3	4	5	6	7	8
20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00

3. The company has projected to add equipments for carrying out scientific research relating to their business @ Rs 0.1 million for each of the eight years.

4. Export turnover receivable in convertible foreign exchange in respect of each of the years of manufactured goods and trading goods (on FOB basis) is as follows:

Manufactured goods:

1	2	3	4	5	6	7	8
5.0	10.0	15.0	18.0	19.0	22.5	27.0	31.5

Trading Goods:

1	2	3	4	5	6	7	8
1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0

5. Cash Compensatory Support (C.C.S.) in respect of exports of manufactured goods receivable for each of the eight years is as follows:

1	2	3	4	5	6	7	8
0.3	0.4	0.5	1.0	1.3	1.5	1.6	1.8

6. Freight and insurance charges in respect of exports of manufactured goods are projected to be as follows:

1	2	3	4	5	6	7	8
0.2	0.3	0.4	0.5	0.7	0.9	1.0	1.2

7. Expenses include provision for retirement gratuity of employees in the 6th, 7th and 8th years at Rs 0.3 million, Rs 0.4 million and Rs 0.5 million respectively. Direct costs of trading goods are 90% of the export turnover of such goods and indirect costs (excluding depreciation) are 20% of total revenue.

8. Details of Preliminary and Preoperative Expenses are as follows:

Rs 1.5 million	– Indirect expenses relating to construction —Plant and Machinery;
Rs 1.0 million	– Indirect expenses relating to construction — Buildings;
Rs 1.0 million	– Preliminary expenses;
Rs 2.5 million	– Indirect expenses not relating to construction.

9. Rate of Depreciation: 25% for Plant and Machinery and 10% for buildings.

Required Compute the total income and total tax liability for each of the eight years. Assume a tax rate of 40 per cent and a surcharge of 15 per cent on income tax.

Solution The computation of the tax liability is shown in Exhibit D.2.

EXHIBIT D.2

NUTS AND BOLTS LIMITED
Computation of Tax Liability

(Rs. in million)

	Yr.1	Yr.2	Yr.3	Yr.4	Yr.5	Yr.6	Yr.7	Yr.8
REVENUE	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00
Less								
EXPENSES								
(See Note 1):	19.69	24.69	29.69	34.69	39.69	44.39	49.29	54.19
	(9.69)	(4.69)	0.31	5.31	10.31	15.61	20.71	25.81
Less:								
1. CURRENT DEPRECIATION (See Note 2)	–	–	0.31	1.82	1.48	1.21	1.00	0.84

(Continued)

EXHIBIT D.2 (Continued)

(Rs in million)

	Yr.1	Yr.2	Yr.3	Yr.4	Yr.5	Yr.6	Yr.7	Yr.8
2. CURRENT CAPITAL EXPENDITURE ON SCIENTIFIC RESEARCH	–	–	–	0.10	0.10	0.10	0.10	0.10
	–	–	–	3.39	8.73	14.30	19.61	24.87
Less:								
1. CARRIED FORWARD BUSINESS LOSS	–	–	–	3.39	8.73	2.26	–	–
	–	–	–	–	–	12.04	19.61	24.87
2. UNABSORBED DEPRECIATION	–	–	–	–	–	6.31	–	–
3. UNABSORBED CAPITAL EXPENDITURE ON SCIENTIFIC RESEARCH	–	–	–	–	–	0.30	–	–
GROSS TOTAL INCOME (G.T.I.)	–	–	–	–	–	5.43	19.61	24.87
Less:								
DEDUCTIONS FROM G.T.I.								
1. UNDER SECTION 80 HHC – PROFIT FROM EXPORT BUSINESS (See Note 3)	–	–	–	–	–	2.88	9.26	11.93
2. UNDER SECTION 81 IA – DEDUCTION FOR NEW INDUSTRIAL UNDERTAKING @ 30% OF G.T.I.	–	–	–	–	–	1.63	5.88	7.46
TOTAL INCOME	–	–	–	–	–	0.92	4.47	5.48
INCOME TAX								
(1) Basic Tax @ 40% of Total Income	–	–	–	–	–	0.37	1.79	2.19
(2) Surcharge @ 15% of Basic Tax	–	–	–	–	–	0.06	0.27	0.33
(3)Total	–	–	–	–	–	0.43	2.06	2.52
BENEFITS CARRIED FORWARD								
(1) Business Loss	9.69	14.38	14.38	10.99	2.26	–	–	–

(Continued)

EXHIBIT D.2 *(Continued)*

(Rs in million)

	Yr.1	Yr.2	Yr.3	Yr.4	Yr.5	Yr.6	Yr.7	Yr.8
(2) Unabsorbed Depreciation	1.56	4.37	6.31	6.31	6.31	–	–	–
(3) Unabsorbed Capital Expenditure on Scientific Research	0.10	0.20	0.30	0.30	0.30	–	–	–

Working Notes

1. Expenses under the head 'Business' before depreciation and capital expenditure on scientific research:

	Yr.1	Yr.2	Yr.3	Yr.4	Yr.5	Yr.6	Yr.7	Yr.8
Expenses as per statement	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00
*	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
	19.65	24.65	29.65	34.65	39.65	44.65	49.65	54.65
**	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	19.69	24.69	29.69	34.69	39.69	44.69	49.69	54.69
Less:								
Provision for Gratuity Not allowed U.S.40 A(7)	–	–	–	–	–	0.30	0.40	0.50
	19.69	24.69	29.69	34.69	39.69	44.39	49.29	54.19

* *Less:* Preliminary Expenses Amortised under financial accounting (10 + 25 = 35) over 10 years.

** *Add:* Preliminary Expenses allowed under Section 35D @ 10% of (2.5% of Capital employed of Rs 18.5 million).

2. Depreciation

Actual Cost:

Plant and Machinery 70 + 15 = 8.5 million

Buildings 90 + 10 = 10.0 million

Rate of Depreciation: @ 25% for Plant and Machinery and 10% for Building. Since these assets were used for less than 180 days during the first year of operation, depreciation @ 50% of normal allowance is available for this year.

Schedule of Depreciation:

	Yr.1	Yr.2	Yr.3	Yr.4	Yr.5	Yr.6	Yr.7	Yr.8
Plant and Machinery :	1.06	1.86	1.40	1.05	0.79	0.59	0.44	0.33
Building :	0.5	0.95	0.85	0.77	0.69	0.62	0.56	0.51
TOTAL	1.56	2.81	2.25	1.82	1.48	1.21	1.00	0.84

(Continued)

EXHIBIT D.2 (Continued)

3. Computation of Profit on Export Turnover

		Yr.6	Yr.7	Yr.8
(a)	Revenue from business:	60.00	70.00	80.00
(b)	C.C.S., freight and insurance	2.40	2.60	3.00
(c)	Total turnover of business (a-b)	57.60	67.40	77.00
(d)	Export turnover of trading goods	6.00	7.00	8.00
(e)	Adjusted total turnover (c-d)	51.60	60.40	69.00
(f)	Adjusted Turnover of Manufactured goods	22.50	27.00	31.50
(g)	Profits under the head 'business'	5.43	19.61	24.87
(h)	90% of C.C.S.	1.35	1.44	1.62
(i)	Profits of the business (g-h)	4.08	18.17	23.25
(j)	Direct costs relatable to (d) – @ 90% of (a)	5.40	6.30	7.20
(k)	Indirect costs of business – 20% of (a)	12.00	14.00	16.00
(l)	Indirect costs attributable to (d) : (k) $\times \frac{(d)}{(c)}$	1.25	1.45	1.66
(m)	Profit on account of export of trading goods [(d) – {(j) + (l)}]	(0.65)	(0.75)	(0.86)
(n)	Adjusted profits of the business – (i) – (m)	4.73	18.92	24.11
(o)	Profit on account of export of manufactured goods (n) $\times \frac{(f)}{(e)}$	2.06	8.46	11.01
(p)	Incentive profit available for deduction : C.C.S. $\times \frac{(e) + (f)}{(c)}$	0.82	0.80	0.92
(q)	Total profit available for deduction U.S. 80 HHC (o) + (p)	2.88	9.26	11.93

APPENDIX E

Environmental Appraisal of Projects*

INTRODUCTION

The effects of actions that are not accounted for in the normal market transactions need to be considered explicitly in the decision-making processes on projects. These effects are to be identified, assessed, and evaluated against the economic advantages arising out of a given action. In this context, the environmental impact assessments/appraisals are considered to be the first step in this process because they give an *opportunity* to man to consider the effects of his actions on the environment.

Economic development is the result of the interaction between natural resources and technology supported by and designed for people. People are the centre for development. Therefore, it is rightly said that all human activity, be it economic, social or anything else, is essentially directed at satisfying "needs" and "wants" of man through "altering" and "using" environmental resources.

TYPES AND DIMENSIONS OF A PROJECT

Broadly, there are two types of projects. The first one refers to those projects that produce physical goods like cement, steel, paper, chemicals etc. These projects, in fact, convert the natural resource endowments into saleable and exchangeable products. As a matter of fact, these projects inflict a large number of physical changes and disruptions on environment and, hence, disturb the environmental and ecological balance. Environmentalists are mostly concerned with such type of projects. The second type refers to those that produce/render various kinds of services such as health, education, transport, energy, defence, law and order, etc. Such projects also cover actions like land reforms, agricultural extension services, sales promotion campaigns, etc. Projects of this type are non-physical in nature and they do not directly cause any physical changes in the environment. However, they bring about significant changes of far-reaching consequences on values, attitudes, lifestyles, social relations, and so on. The net effect of such projects is the creation of new wants and needs in society. They ultimately promote consumerism in the society and thereby increase the number of manufacturing projects. Thus, both are interrelated.

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* This appendix has been contributed by Dr. N. Naganna, Professor, Indian Institute of Management, Bangalore. This is based upon the author's class notes on the same subject.

Each project has two dimensions: (a) the intended objectives/purposes—they are also called stated goals/benefits; and (b) the unintended consequences. They are also called externalities or social costs which are unplanned, unwanted, and unanticipated. Environmental management or planning is the study of the unintended consequences of a project. Its purpose is to identify, examine, assess, and evaluate the likely and probable impacts of a proposed project on environment and, thereby, to work out the remedial action plans to minimize the incidence of adverse impacts. It is not anti-development nor is it against the projects. Its goal is development without damage or least damage.

STRESSES ON ENVIRONMENT

Environmentalists have identified four types of different stresses or pressures that are being continuously inflicted on environment. They are:

(i) *Eutrophic Stress* Refers to the release of various kinds of wastes into the river and other water bodies and their consequent drying.

(ii) *Exploitative Stress* Refers to the exploitation of natural resources endowment for production and consumption purposes through agriculture, industry, extraction, fishing etc. It is important to note that the rate of exploitation has a relevance to the nature's capacity to reproduce.

(iii) *Disruptive Stress* Refers to the physical alterations in nature resulting from such activities like forest clearance, highways, railways, factory buildings and so on. These physical changes disturb the environmental and ecological balance.

(iv) *Chemical and Industrial Stress* This results mainly from the developments in "science and technology" and their applied fields like industry, warfare and agriculture. This comprises mainly the pollutants and effluents of all types, radiation etc.

Strategies to meet these threats to natural environment through pollution, destruction and over-use can be: (a) preventive or (b) regulatory. It is in this context that the environmental appraisal of projects is gaining significance with a hope of achieving sustainable development in harmony with environment.

MEANING AND SCOPE OF ENVIRONMENT

The word "environment" is defined to include everything external to man/organism. It covers the region, surroundings, or circumstances in which anything exists. It is broadly divided into two components. The first one is the abiotic or inorganic milieu, comprising the physical elements like land, water, atmosphere, climate, sound, odours, and tastes. They are the inanimate elements of the habitat systems. The other one is the biotic or the organic milieu consisting of animals, plants, bacteria, viruses, all other living organisms, and the social factors including aesthetics. They are the animate elements.

There is another definition particularly relevant in the context of projects. Here, the term "environment" is defined as:

> The surrounding zone (the specific zone to be affected by the project), all natural resources (physical and biological),and the human resources (people, economic development and quality of life values).

This definition is comparatively more specific, focussed, and clear cut than the earlier one which was too general and unfocussed. This is more suited to operationalize, quantify, and measure the environmental impacts of a given action. The contentious issue in this definition is the surrounding zone or the project vicinity. However, a distinction has to be made between the "legal boundary" which is the area legally occupied by a project, and the "environmental boundary" which stretches much beyond the legal boundary. In fact, this is the area around the project that is likely to be affected environmentally by the project operations. The extent of environmental boundary for a project depends, among other things, on the diffusion factors like wind speeds and directions, elevations, etc. It varies from project to project and location to location for the same project.

There is yet another definition of environment as below:

> The external, natural, physical and residential conditions which affect man directly and indirectly and which are, in turn, influenced by economic decisions and technological developments.

This definition implies a complex interactive model between man, environment, and science and technology, the outcome of which will be economic development. As a matter of fact, projects facilitate such an interaction.

Environmental management, a term encompassing environmental planning, protection, monitoring, assessment, research, education, conservation, and sustainable use of resources, is now accepted as a major guiding factor in all the economic decision-making processes on development or otherwise. Subsequently, a wide network of legislation came into being. Now, environmental clearance for all the major projects on the basis of their Environmental Impact Statement (EIS) has become legally mandatory.

ENVIRONMENTAL RESOURCES/VALUES (ER/Vs)

Since the word 'environment' is an all-inclusive concept encompassing everything external to us, it is difficult to operationalize and apply to particular situations like the projects. For the purposes of operationalization and practical application, the environmentalists have developed a concept called 'Environmental Resources/Values' (ER/Vs). It is defined as an aspect of environment which is of benefit to man. The environmentalists have identified and classified various components of environment (that is, ER/Vs) into four levels as below:

(a) Level–1 : *Physical Resources*, covering land, water and air.

(b) Level–2 : *Ecological Resources*, consisting of acquatic, terrestrial and endangered (rare) species (other than man).

(c) Level–3 : *Human Use Values*, covering transport, agriculture, water supply, recreation, mining, industry, flood control, etc.

(d) Level–4 : *Quality of Life Values*, covering socio-economic, cultural and aesthetic aspects.

Thus the whole environment is decomposed into several operationally feasible components or elements. These elements can further be subdivided into several related items. Alternatively, some other environmentalists identify and classify the various elements of environment broadly under eight types which are called *Environmental Attributes* (EA). They are: (a) air, (b) water, (c) land, (d) ecology, (e) sound, (f) human aspects, (g) economics, and (h) resources. Each one can further be subdivided into different related elements.

In the context of environmental appraisal of projects, one can follow either of the classifications, viz., Environmental Resources/Values (ER/Vs) or the Environmental Attributes (EA). As a matter of fact, they can be evaluated and assessed individually with respect to the impacts they receive or the changes they undergo due to the proposed project. Since there will be a variety of types of impacts of varying degrees from a project, the decomposition of environment unit into various quantifiable elements will enable the analyst to give focus and direction to his impact assessment analysis.

An environmental effect is considered as the effect of natural or man-made actions which alter environment (as measured by physical, chemical, and biological parameters). Our concern is, however, on man-made actions. The nature and extent of environmental impacts including magnitude, severity, urgency, risk etc., of a project in the ultimate analysis depends upon:

(a) Nature, size and type of the project: such as manufacturing, services, agriculture, mining, logging, power, harbour, chemicals, sugar, etc.
(b) Technology.
(c) Location/eco-region: such as urban or rural areas, coastal, river valley, forest/hill areas or any of the eco-systems as described earlier.

MEANING AND SCOPE OF ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AND ENVIRONMENTAL IMPACT STATEMENT (EIS)

Environmental Impact Assessment (EIA) and the Environmental Impact Statement (EIS) are said to be the instruments through which the environmental management tries to accomplish its objective. The basic premise behind the EIS/EIA is that no one has any right to use the precious environmental resources resulting in greater loss than gain to society. From this, it follows that the aim of EIS is to seek ways by which the project can proceed without any irrepairable losses to environment and minimum losses if any, so that the net effect will be a desirable gain.

Environmental Impact Assessment (EIA) is defined as: "An activity designed to identify, predict, interpret, and communicate information about the impact of an action on man's health and wellbeing (including the wellbeing of ecosystems on which man's survival depends). In turn, the action is defined to include any engineering project, legislative proposal, policy programme, or operational procedure with environmental implications." An EIA, therefore, is a study of the probable changes in the various socioeconomic and biophysical attributes of the environment which may result from a proposed action.

On the other hand, Environmental Impact Statement (EIS) is defined as:

> A report, based on studies, disclosing the likely or certain environmental consequences of a proposed action, thus alerting the decision-maker, the public and the government to environmental risks involved; the findings enable better informed decisions to be made, perhaps to reject or defer the proposed action or permit it subject to compliance with specific conditions.

The EIS is a document prepared by an expert agency on the environmental impacts of a proposed action/project that significantly affects the quality of environment. The EIS is used mainly as a tool for decision-making. At times, the EIA and EIS are used interchangeably as synonyms. But both are different activities with a lot of commonalities and with a common purpose. The basic difference between the two is that the EIA is carried out by the expert agency while the EIS as a tool is given to the decision-makers in different formats. As a matter of fact, the EIS is the outcome of EIA. It is better to consider the environmental consequences during the project planning and design stage itself so as to avoid higher costs of future remedial actions by prudent planning and early preventive measures.

Objectives of EIS

(a) To identify and describe (in as quantified a manner as possible) the environmental resources/values (ER/Vs) or the environmental attributes (EA) which will be affected by the proposed project, under existing or "with or without project" conditions.

(b) To describe, measure, and assess the environmental effects that the proposed project will have on the ER/Vs (again, in as quantified a manner as possible), including positive effects which enhance ER/Vs as well as the negative effects which impair them. Direct or indirect and short term or long term effects are to be considered. This would also include the description of the specific ways by which the project plan or design will minimize the adverse effects and maximize positive effects.

(c) To describe the alternatives to the proposed project which could accomplish the same results but with a different set of environmental effects. Energy generation by thermal, hydel, and nuclear modes would explain the case in point. Further, alternative locations are also considered.

Guidelines on the Scope and Contents of EIS/EIA

The following are the commonly accepted points to be covered in an EIS study/report:

(a) A description of the project proposed action; a statement of its purpose and a description of all relevant technical details to give a complete understanding of the proposed action, including the kinds of materials, manpower/resources etc., involved.

(b) The relationship of the proposed action to the land-use plans, policies and controls in the affected area or the project-vicinity. It is necessary to gain a complete understanding of the affected environment. What is the nature of biophysical and socioeconomic characteristics that may be changed by the action?

(c) The probable impacts of the proposed project on environment is a very important aspect to be considered in detail. It is necessary to project the proposed action into the future and to determine the possible impacts on the environmental attributes. The changes are to be quantified wherever possible.

(d) Alternatives to the proposed action, including those not within the existing authority/agency.

(e) Any probable adverse environmental effects that cannot be avoided and stating how each avoidable impact will be mitigated.

(f) The relationship between local short term uses of man's environment and the maintenance of and enhancement of long term productivity.

(g) Any irreversible and irretrievable commitments of resources (including natural, cultural, labour, and materials).

(h) An indication of what other interests and considerations of governmental policy or programme are thought to offset the adverse effects identified.

As seen by its purpose, scope and contents, the EIA is a very complex exercise due to the fact that many and varied types of projects are proposed for an equally numerous and varied kinds of environmental settings. Each combination of projects and the complex environmental settings results in a unique cause-condition-effect relationships with regard to their impacts. Therefore, each combination must be studied individually in order to accomplish a comprehensive analysis.

METHODOLOGY FOR CONDUCTING AN EIS STUDY

So far, there is no consensus on any particular procedure. This is because of the difficulties in quantifying the effects which are often intangible, complex, and imperceptible in nature. It is difficult to develop meaningful parameters to represent the effects and their quantification. The major problems in this regard are:

(i) The diffused nature of impacts both over time and space; and the lags in impacts after the cause worked.

(ii) An environmental effect is the joint product of several pollutants.

(iii) Inadequacy of techniques to estimate the impacts and their costs.

(iv) Since the impacts are imperceptible, people are not aware of the impacts.

Due to the complex problems involved in identification and quantification of effects, all attempts to develop quantitative approaches to EIA (including the checklists, matrices, networks, flowchart relationships, and map overlays) have been essentially subjective with the quantification depending mostly on the background and bias of the investigator or observer.

At present, the generally accepted approach for making the EIS is an item-by-item review of effects on the individual environmental resources/values (ER/Vs), including both the identification of ER/Vs, and description and quantification of the effect to the extent possible. Then, it is possible to group these effects in a systematic manner. The following are the major practical steps in this approach.

(a) Make a rapid or quick scanning or appraisal of the basic environmental resources viz., land, water and air, at the macrolevel, say at the district level in which the project is to be located. This scanning is meant to evaluate the extent of fragility and exploitation of the endowed resource-base, including the human resources. Then, relate the project to the regional environment in broad terms.

(b) Demarcate the project vicinity or the surrounding zone of the project. Maps can also be used.

(c) Identify, assess, and describe all the environmental attributes as given in a tabular form earlier; or the environmental resources/values (ER/Vs under four levels) as given earlier, endowed in the project vicinity. This would give a total description of the environment before the start of the project.

(d) Rank or prioritize the identified ER/Vs by their fragility, importance, relevance and quality. This would help to concentrate on the very significant items rather than spreading the efforts too thinly over a large number of items of lesser significance.

(e) Carry out the item-by-item review of effects of the proposed project on the already identified individual ER/Vs embedded in the project vicinity.

(f) Arrange or group the effects in a systematic manner, preferably in a format.

(g) Prepare the remedial plans for mitigating the adverse effects. They can be: (i) Corrective; (ii) Compensatory; or (iii) Enhancing.

By following the above practical steps sequentially in that order, one can make an environmental appraisal of any type of project. Through EIS/EIA, the environmental protection planning is made compatible with the developmental perspectives.

Some Major Issues in the Preparation of EIS/EIA

The following are the major issues reported to be encountered commonly while conducting and preparing the EIS/EIA. Some of the issues cannot be resolved. In the absence of better alternatives, the analyst has to accept the issues as they are.

(i) Determining the Environmental Impacts This is the central theme in any EIS/EIA. It is a very complex process. At the outset, a distinction has to be made between the environmental impact and the changes in environmental attributes. Our interest is on the "impacts" and not on the 'changes' which normally take place even without the project. The determination of environmental impacts involves: (a) identification of impacts on environmental attributes or the ER/Vs, (b) measurement of impacts on attributes, and (c) aggregation of impacts on attributes to reflect the total impact on environment.

(ii) With and Without the Project The environmental impacts are measurement of attributes with and without the project or activity at a given point in time. But the changes in the attributes take place over time without the activity. Therefore the impact must be measured in terms of "net" change in the attribute at a given point in time.

(iii) Identifying the Impacts The number of attributes to be evaluated is practically infinite because any characteristic of the environment is considered to be an attribute. Therefore, they have to be reduced to manageable numbers. Thus, duplicative, redundant, difficult to measure, and obscure attributes may be eliminated in favour of those that are more tractable. This implies that some attributes which are difficult to measure or conceptualize, may still remain to be examined. In this case, bias and subjectivity are likely to be crept in.

(iv) Characteristics of the Base Conditions Prior to the Activity: The nature of the impact is determined by the conditions of the environment existing before the project. The assessment of the characteristics of the base is a critical factor.

Geographic Characteristics: The same activity produces different impacts on a particular attribute, say water quality, over different geographical areas. The spatial distribution of different activities introduces one of the difficult elements in comparing one activity and its impact with another. This issue becomes particularly critical while making choices between projects.

(v) Role of Attributes Though the impacts are considered to be the effects on the definite discrete attributes of the environment, the actual impacts are not correspondingly well

categorised. Nature does not necessarily respect man's discrete categories. Rather, the actual impacts may be the effects of varying severity on a variety of interrelated attributes. The issue is one of identifying and assessing the cause-condition-effect in order to work out the remedial measures.

(vi) Measurement of Impact Ideally, all impacts must be translatable into common units. However, this is not possible because of the difficulty in defining impacts in common units (e.g., on income and on water quality). In addition, the quantification of some impacts may be beyond the state of the art.

(vii) Aggregation Problem After measuring the project impacts on various individual attributes or ER/Vs, one encounters the problem of how to aggregate all impacts (quantitative and qualitative) thus assessed to arrive at a single composite measure to represent the 'total activity impact'. This would involve expressing the various impactmeasures in common units which is very difficult. Some use a weighting procedure to accomplish this which is again subjective. There is another associated problem of summing up and comparing with the impact of an alternative activity.

(viii) Secondary Impacts Secondary or indirect impacts on environment should also be considered particularly in relation to the infrastructure investments that stimulate or induce secondary effects in the form of associated investments and changed patterns of social and economic activity. Such induced growth brings significant changes in the natural conditions. Similarly, there can also be significant secondary impacts in the biophysical environment.

(ix) Cumulative Impacts Here, cumulation refers to the similar activities spread over in an environmental setting like hotels, beach resorts, surface or underground mines, industrial estates, etc. A single individual activity may produce a negligible effect on environment. However, a series of similar activities may produce significant cumulative effect on certain aspects of environment. This raises the question of how to deal with these significant cumulative effects. Therefore, it is suggested to prepare an environmental impact assessment (EIA) on broad programmes rather than on a series of component actions (e.g., industrial estates, mining sector, tourism industry, etc.). Or, alternatively, one can prepare an EIA for a particular geographical area where a series of similar activities are located (e.g., mining areas, coastal line for beach resorts, etc.).

(x) Reporting Findings The results should be displayed in such a way that it makes easy and clear to comprehend the total impacts of an activity from a brief review. It is suggested to display the impacts on a summary sheet in a matrix form.

The knowledge about the issues as explained above, however complex they are, will be useful in understanding the processes and complexities involved in preparing an EIS/EIA. Such an awareness will help improve the understanding of EIS, leading to more objective, informed and unbiased decision-making on activities/projects.

Choice of a Methodology

Many impact assessment methodologies have been developed in the Western industrialized countries as a response to the various legislative control and regulatory measures as also to suit divergent environmental situations and purposes.

The choice will decide the depth of analysis to be carried out in a particular impact assessment. The choice of a methodology depends on: (a) needs of the user, (b) type of project; its size and technology, and (c) location; type of ecosystem.

Depending on these factors, one may be more useful than the other methodology. Therefore, the analyst must decide which one will best fit for a given task and situation. The following are the important considerations for making a choice on the methodology for preparing an EIS/EIA.

(i) *Use*: Is the EIS for a decision or for information? If it is for a decision, it requires greater emphasis on identification of key issues, quantification and comparison of alternatives. If it is for information, it requires a more comprehensive analysis and concentration on interpretation of the significance of a broad list of possible impacts.

(ii) *Alternatives*: Are alternatives fundamentally or incrementally different?

(iii) *Resources*: How much time, skills, money, and data are available? More in-depth and quantitative analysis require more of everything.

(iv) *Familiarity*: Is the analyst familiar with both the types of project proposed and the physical site?

(v) *Issue Significance*: How big is the issue? The bigger the issue, the greater the need to be explicit, to quantify, and to identify key issues.

(vi) *Administrative Constraints*: Are choices limited by governmental procedures and format requirements? Some policy guidelines may rule out some tools by specifying the range of impacts to be addressed.

Impact Assessment Methodologies

The impact identification and assessment can be made through several ways. Each one represents a methodology. Besides the one already explained, there are six other different methodologies in the literature based on the way the impacts are identified and assessed. A critical overview of the methodologies is given in Exhibit E.1.

(1) *Ad Hoc*: These methodologies provide a minimum guidance for impact assessment. They merely suggest broad areas of possible impacts (e.g., impacts on lakes, forests, etc.,) rather than defining specific parameters to be investigated. This is given exogenously to the analyst.

(2) *Overlays*: These methodologies depend upon a set of maps on the environmental characteristics (physical, social, ecological, and aesthetic) of the proposed project's vicinity. These maps are overlaid to produce a composite characterization of the regional environment. Impacts are then identified by noting the impacted environmental attributes within the project boundaries.

(3) *Checklists*: The methodologies present a specific list of environmental attributes to be investigated for possible impacts. They need not necessarily attempt to establish the cause-effect links to project activities. They may or may not include guidelines about how attribute data are to be measured and interpreted.

(4) *Matrices*: These methodologies incorporate a list of project activities with a checklist of potentially impacted environmental attributes. Then, the two lists are related in a matrix form which identifies the cause-effect relationships between specific activities and impacts. The matrix methodologies may either specify which actions affect which attributes, or may simply list the range of project activities and environmental attributes in an open matrix to be completed by the analyst.

(5) *Networks*: These methodologies work from a list of project activities to establish cause-condition-effect relationships. It is generally felt that a series of impacts may be triggered by a project action. They define a set of possible networks and allow the user to identify impacts by selecting and tracing out the appropriate project actions.

(6) *Combination Computer-aided*: These methodologies use a combination of matrices, networks, analytical models, and a computer-aided systematic approach. Since this is a combination of difficult methodologies, it is a multiple-objective approach to: (a) identify activities associated with the governmental policies and programmes; (b) identify potential environmental impacts at different levels; (c) provide guidance for abatement and mitigation techniques; (d) provide analytical models to establish cause-effect relationships and to quantitatively determine potential environmental impacts, and (e) provide a methodology and a procedure to utilize this comprehensive information in decision-making.

Evaluation of a Methodology

An environmental impact assessment (EIA) must effectively deal with four key problems: (a) impact identification; (b) impact measurement; (c) impact interpretation, and (d) impact communication to users. These criteria can be used for analysing a methodology and determining its weaknesses and strengths. It also helps in choosing methods which are most appropriate for a particular situation. The above six methodologies display variety in conceptual framework, data formats and data requirements as well as in manpower, monetary and time resource requirements. An EIA team can use more than one method.

EXHIBIT E.1

A Critical Overview of EIA Methodologies

Methodology	Areas of usefulness	Drawbacks
(a) Ad Hoc	– Simple and no training/skills needed. – Indepth and focussed analysis on few; When no expertise and resources available, this is the best. – Gives preliminary understanding – Project's effects on environment given without any weighting and cause-effect relations.	– Restricts to broad areas only. – Not all relevant impacts covered. – Selective and biased. – Lacks consistency due to different criteria to evaluate different groups of factors.
(b) Checklists	– Strong in impact identification. – Effective in evoking public attention. – Simple and easy to understand; comprehensive. – Most useful at the stage of initial environmental examination (IEE).	– Scaling and weighting subjective. – Leaves interpretation to decision makers. – Measurement deficient.

(Continued)

EXHIBIT E.1 (Continued)

Methodology	Areas of usefulness	Drawbacks
(c) Matrices	– Provides cause-effect relations between project activities and impacts on various attributes. – Graphical display of impacts gives better understanding. – Strong in impact identification and their interaction is possible.	– Information is lost due to quantification. – Scaling and weighting become subjective.
(d) Networks	– Capable of identifying both direct and indirect effects and their interaction. – Capable of incorporating mitigation and management measures at the planning stage of a project.	– Less useful in considering socioeconomic environment. – Display becomes large and unwieldy when large industrial complexes or regional plans are considered.
(e) Overlays	– Useful in site and route selection. – Effective presentation and display. – Useful in transport projects and road route alternatives: land use planning.	– Quantification and measurement weak. – Not all impacts covered. Higher order impacts cannot be identified. – Social environment not considered. Subjective – Self limiting in scope.

APPENDIX F

Application for Financial Assistance

The central financial institutions have prescribed a common application form, 54 pages long, which seeks information along the following lines.

1. *General Name*: Form of organisation; date of incorporation/registration; date of commencement of business, sector business house to which the concern belongs, applicability of the MRTP Act; location; nature of project (new/expansion/modernisation/diversification); brief particulars of the project; nature of industry and products; financial assistance applied for; and foreign currency loan/guarantee applied for.

2. *Promoters*: Bio-data of the main promoter, brief write-up on other companies promoted by the promoter—in case the promoter is a limited company, a brief write-up on the activities and past performance of the company.

3. *Particulars of the Industrial Concern*: Brief history; list of subsidiaries; particulars of holding company; details of directors; certified copies of audited balance sheets and profit and loss account for the last five years and brief explanations for year-to-year variations in production, sales, stocks, profits, etc., and contingent liabilities; details of asset revaluation, if any, during the existence of the company and the reasons thereof; list and bio-data of existing key technical and executive staff and number of supervisory, skilled, semi-skilled and unskilled personnel; organisation chart showing the lines of authority; existing long-term and short-term borrowings as set out in Forms II and III; distribution of shareholding as per Form IV; company's tax status; manufacturing facilities separately at each plant; figures of licensed capacity, installed capacity, production and sales (quantities and value net of excise duty) of each major products/product group requirement of various utilities and services and the arrangements for their supply; details of insurance; details of pending litigation; details of research and development activities of the company; preventive maintenance adopted by the company.

4. *Particulars of the Project*: Details of the project for which financial assistance is required in terms of the following (copy of the project report/feasibility report, if any, to be enclosed).

   A. Capacity: Present installed capacity, maximum production achieved, proposed installed capacity, and maximum production envisaged for various products; section-wise capacities for the major sections of the plant; specifications of major products and by-products.

B. Process: Details of technical process; labour intensiveness of the process; advantages/disadvantages of the alternative process with reference to employment potential; reasons for choosing the particular process; copy of process flow chart with material balance, utilities and process parameters; application of the proposed process in the country.

C. Technical Arrangements: Technical arrangements made/proposed; write-up on the collaborator, in case of collaboration; copy of collaboration agreement, copy of government approval for the collaboration, copy of government approval for availing of the services of foreign technicians; particulars of consultants.

D. Management: Proposed arrangements for executive management, particulars of proposed key technical, administrative and accounting personnel; proposed organisation chart; proposed cost and budgetary control system, management reporting and inventory control system, purchase of raw materials, components etc.

E. Location and Land: Location of the plant, land requirement and the arrangements thereof, locational advantages; particulars in respect of the land acquired/proposed to be acquired; copy of sale/lease deed, copy of soil test report, copy of government order converting the land into industrial land if applicable, location map, site plan.

F. Buildings: Arrangements made/proposed for constructing the buildings (particulars of buildings as per Form V); copy of master plan showing location of buildings and roads, power receiving station, railway siding, tube well, etc., copy of equipment layout or plan of buildings indicating the flow of materials; particulars of architect; copy of agreement with architects, copy of published write up/brochure on architects.

G. Plant and Machinery: Basis of selection of equipment, list of imported and indigenous plant and machinery acquired/to be acquired along with detailed specifications as per Forms VI and VII, layout of the plant and machinery indicating the flow of material.

H. Raw Materials: Requirement of raw materials, components, chemicals, etc., as per Form VIII; price or distribution controls if any, on any of the items listed above, detailed note on the arrangements made for obtaining the raw materials/chemicals; mining lease, if any, and details thereof; copy of agreement for mining lease and expert's report regarding the quantity and value of reserves.

I. Utilities: Details about power (source of power and supply voltage, maximum demand, connected load, peak hour requirements, contracted load, power tariff, cost of power), copy of letter of sanction for power, copy of agreement with Electricity Board, copy of electrical layout of the plant, a note on power generation, demand and supply of power in the State, present and projected; details about water (requirement for various purposes, sources of water, sources of water arrangements proposed and water charges payable, capacities of tanks, reservoirs, water treatment arrangements proposed), layout for water system, copy of letter of sanction of water by municipal/local authorities, where applicable, copy of water analysis report; details for steam (steam requirement and steam balance, capacity and type of the boiler with detailed specifications), layout of the steam system; details for compressed air, fuel, etc., copies of letter of allotment of coal/furnace oil from the concerned authorities, details for transport (arrangements proposed for carrying raw materials and finished goods, provision for own trucks, railway siding etc., and arrangements with private truck operators indicating rates, subsidy, if any, available, etc.)

J. Effluents: Details of the nature of atmosphere, soil and water pollution likely to be created by the project and the measures proposed for control of pollution permissions for the disposal of effluents where necessary; copy of approval from concerned authorities for the proposed arrangements.

K. Labour: Estimates of total requirements and availability of skilled and unskilled labour, plans for training of personnel, manpower development programme, category-wise classification of total personnel requirements.

L. Quarters and Labour Housing: Existing and proposed arrangements for housing staff and workers, classified as follows; senior executives, other executives, supervisors, labour.

M. Schedule of Implementation: Manner in which the design, engineering, erection, installation and commissioning of the projects will be carried out; progress made so far in the implementation of the project; schedule of implementation showing the commencement and completion of the following acquisition of land, development of land, civil works, placement of order and delivery at site of plant and machinery (imported, and indigenous), arrangements for power, arrangements for water, erection of equipment, commissioning, procurement of raw material and chemicals, training of personnel, trial runs, and commercial production, PERT chart.

N. Other Projects of the Concern: Details of any other new/expansion/modernisation, etc., projects which are under implementation or which the company/promoters propose to implement, giving the estimated cost, means of financing and the present status.

5. *Cost of the Project*: Estimate of cost of project under the following heads (details may be furnished as per Form IX): (i) land and site development, (ii) buildings, (iii) plant and machinery (imported and indigenous), (iv) technical know-how fees, (v) expenses on foreign technicians and training of Indian technicians abroad, (vi) miscellaneous fixed assets, (vii) preliminary and preoperative expenses, (viii) provision for contingencies, and (ix) margin money for working capital; basis of cost estimate (such as quotations, orders placed etc.) bringing out the built-up provision for cost escalation, if any; estimates of contingency/escalation provisions as per Form IX-A and margin money for working capital as per Form IX-B.

6. *Means of Financing*: Means of financing envisaged divided as follows: share capital (equity and preference), rupee loans, foreign currency loans, debentures, internal cash accruals, and others; details of the means of financing envisaged and the proposals for raising share capital as per Form X and Form XA respectively; basis of estimation of internal accruals; arrangements of letter sanctioning assistance; sources of foreign exchange and arrangements, if any, made for obtaining foreign exchange; sources from which expenditure already incurred has been financed as per Form XB; promoters' contribution to project cost; list of persons/firms who would be contributing to the promoters' share of the capital and the respective amounts; details of security proposed to be offered for loan and/or guarantee for deferred payments on plant and machinery or guarantee for foreign currency loans; copy

of letter from bank indicating its willingness to guarantee a loan, in case a bank guarantee is proposed to be offered instead of mortgage of fixed assets.

7. *Marketing and Selling Arrangements*: Copy of market survey report, if any, conducted by the company or independent consultants; brief notes on the products, their major uses, scope of the market, possible competition from substitute products, etc., special features (regarding quality, price, etc.) of the product which would result in consumer preference in relation to competitive products; detailed notes on the existing and future demand and supply of the produts proposed to be manufactured; assessment of likely competition in the future and special features of the project which may enable it to meet the competition; export possibilities and the nature of competition to be faced in foreign countries—comparative data on manufacturing costs and prices in selected competing countries; export commitments of the company as part of the government requirements and arrangements proposed for meeting the same—export incentives available; international CIF, FOB prices and landed costs of the proposed products; list of principal customers and particulars of any firm arrangements entered into with them; particulars of government controls, restrictions, etc., if any, on the sale price, distribution, import, export, etc., in respect of the products proposed to be manufactured; nature of selling arrangement (direct, through distributors, or through selling agents), nature of proposed selling organisation for direct sales, particulars of proposed selling arrangements both in India and abroad and commission proposed to be paid, brief note on the selling agent's organisation; copy of the agreements with selling agent; particulars of any sole selling agency, where proposed, for any of its products; details regarding the trend in prices during the last five years; the basis on which prices are fixed, if the prices are controlled by the government or on a voluntary basis; in case of agro-based/agriculture input industries, the company's scheme for educating the farmers to use the product/to grow the produce required.

8. *Profitability and Cash Flow*: Estimates of cost of production and working results for the first ten years of operation as per Forms XI and XII respectively (for expansion/ diversification of existing companies two sets of profitability statements may be prepared—one for the project and the other for the existing operations only); cash flow statement for the company as a whole for ten operating years of the project in Form XIV, based on working results in Form XII, projected balance sheet for ten operating years for the company as a whole as per Form XV; break-even capacity level.

9. *Economic Considerations*: Prices of competing import/export products giving a break up as FOB, CIF, landed cost (including import duty) and selling price; detailed explanation for differences in selling prices of the products and those of imported goods with quantitative data on differences in cost of production (such as scale of operation, differences in costs of inputs and various local duties and taxes); international/CIF/FOB prices of all inputs which can either be imported/exported; details of duties, taxes and incentives (excise duty, export duty, export assistance in the form of replenishment license, duty drawback, cash subsidy, any other); brief write up on the economic benefits to the country in general and the region in particular, on account of the proposed project; contribution of the unit to the establishment of ancillary industries in the region.

10. *Government Consents* Details of the following licenses/consents required for the project in terms of date of issue, validity period, and present issue, if not already issued; (i) letter of intent, (ii) industrial license, (iii) capital goods clearance, (iv) import license, (v) foreign exchange permission, (vi) approval of technical/financial collaboration,

(vii) clearance under MRTP Act, (viii) consent of the Controller of Capital Issues, (ix) any other (specify); copies of licenses/consents etc., received; special conditions attached to the licenses/consents and the undertakings given by the company in connection with them.

11. *Declaration*: A declaration by the applicant that the information, statements, and papers furnished are true and correct.

LIST OF FORMS

The following is the list of forms to be submitted along with the application for financial assistance.

I Letter Addressed to the Bankers
II Existing Long-term Borrowings
III Existing Short-term Borrowings
IV Distribution of Shareholdings
V Particulars of Buildings
VI Particulars of Imported Machinery
VII Particulars of Indigenous Machinery
VIII Raw Materials Requirements
IX Estimates of the Cost of Project
IXA Calculation of Contingency
IXB Calculation of Margin Money
X Means of Financing
XA Proposal for Raising Share Capital
XB Sources of Expenditure Incurred
XI Estimates of Cost of Production
XII Estimates of Working Results
XIIA Estimates of Production and Sales
XIIB Calculation of Wages and Salaries
XIII Unit Cost of Production
XIV Cash Flow Statement
XI Projected Balance Sheet

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